The regulation of radioactive waste in South Africa

by

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LIST OF ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
AR	At-Reactor
AFR	Away From Reactor
DEAT	Department of Environmental Affairs and Tourism
EIA	Environmental Impact Assessment
EW	Exempt Waste
HLW	High Level Waste
ILW	Intermediate Level Waste
IAEA	International Atomic Energy Agency
LILW-LL	Long Lived Low and Intermediate Level Waste
LLW	Low Level Waste
MPRDA	Mineral and Petroleum Resources Development Act
NNR	National Nuclear Regulator
SANS	South African National Standards
LILW-SL	Short Lived Low and Intermediate Level Waste

1 Introduction

Radioactivity occurs naturally, or may be a by-product of the generation of nuclear power and the application of radioactive material in industries, mines, research and medical use.[1] Radioactive waste is classified according to the concentration of radioactive activities in the specific waste. A distinction is drawn between low, intermediary and high levels of radio activities.[2] Low-level waste is generated from hospitals, laboratories and industry. It consists, for example of paper, rags, tools, clothing, and filters that contain small amounts of mostly short-lived radioactivity.[3] Intermediate-level waste contains higher amounts of radioactivity and may require special shielding. It typically consists of resins, chemical sludge and reactor components, or contaminated materials from reactor decommissioning.[4] High-level waste may be spent fuel itself, or the principal waste separated from reprocessing fuel. It contains highly-radioactive fission products and some heavy elements with long-lived radioactivity such as mining or nuclear waste. Radioactive waste cannot be made harmless through chemical or physical treatment and stays active until the atoms are naturally dissolved.[5]

The options to treat radioactive waste are confined. In the case of low-level radiation the atoms can be weakened to such an extent that they can be released directly into the environment. Another option is to concentrate the radioactive atoms in order to separate the non-radioactive material from the radioactive material. The non-radioactive waste could then be released into the environment while the radioactive waste that then consists of a much smaller volume can be stored until it is declared safe. High levels of radioactivity cannot be weakened.[6]

Radioactive waste requires thousands of years before the waste can be declared innocuous and thus needs to be managed and stored in such a manner that no harm

1 Nathanson *International management* 363; González *The Safety of Radioactive Waste Management* 11; Fiehn and Ball *Integrated Waste Management* 2-3.
2 Eskom fact sheet on nuclear waste; Nathanson *International management* 363.
3 See par 2.
4 Nathanson *International management* 364; *Chernobyl's Health, Environmental and Socio-Economic Impacts.*
5 Eskom fact sheet on nuclear waste; Nathanson *International management* 364.
6 Fiehn and Ball *Integrated Waste Management* 2-3; Nathanson *International management* 364; Ahearne *Radioactive waste: The size of the problem* 24-29.

is done to the environment or human health. Waste with high level radiation is the biggest problem and is stored in temporary storing facilities until more permanent and safe storage facilities are found or developed. No guarantee exists that a certain storage facility will isolate radioactive waste on a permanent basis and neither does an absolute certainty regarding human monitoring exist.[7]

An additional waste problem that recently became known is the dismantling of an old or unused industrial premise or mine that had radioactive activities during its operational phase.[8] During the production phase of that industry the structural material might have been polluted or contaminated with radiation and thus also would need to be isolated in a sound manner. Due to the lack of proper regulation over these materials it occasionally occurs in the closing phase of that industry that the contaminated material end up in water streams and other sensitive areas.[9]

Radioactive waste in water systems and especially in the sea endangers all forms of life due to the fact that the pollution may be spread over large areas by way of biological mechanisms. Radioactive waste in the sea can, for example, re-concentrate and wash out on various coastlines. Countries that dump radioactive waste at sea may therefore cause a negative impact on other countries, including human life, and badly damage biodiversity.[10]

The International Atomic Energy Agency (IAEA) was established due to the international importance of the treatment of radioactive waste. The IAEA adopts international standards for the management, processing, handling and storage of radioactive waste,[11] for protection of health and safety, the minimisation of danger to

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7 Nathanson *International Management* 364; Albrecht, Amey and Amir *Siting of Radioactive Waste Facilities* 650-655; IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety Guide No GS-G-3.3; see par 3.

8 Ahearne *Radioactive waste: The size of the problem* 24-29; Nathanson *International management* 365; www.pub.iaea.org/MTCD/publications/PDF/Pub989e-scr.pdf.

9 Nathanson *International management* 366; www.pub.iaea.org/MTCD/publications.

10 Ahearne *Radioactive waste: The size of the problem* 24-29; Nathanson *International management* 366.

11 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety Guide No GS-G-3.3; see par 3.

life and property, and to provide for the application of these standards.[12] South Africa is a member of the IAEA and therefore has to take the standards set by the IAEA into account.[13] The IAEA already adopted standards for example, for the management of radioactive waste in nuclear installations, nuclear facilities, mining and the application of radioactive sources. These standards provide, amongst others, responsibilities for the regulators and the operators of radioactive waste.[14] Member countries, such as South Africa may apply the IAEA's best practices and principles to formulate their own legal frameworks.

Some of the principles developed within the environmental protection paradigm[15] and others developed from international nuclear discussions.[16] The principles that are important regarding the regulation of radioactive waste are amongst other the precautionary principle, the polluter pays principle and the principle of cooperation that will be discussed in more detail later on. These principles should form the point of departure of a radioactive regulatory framework and should be embedded in legislation.[17]

There are various acts regulating radioactive waste in South Africa, either directly or indirectly. The applicable legislation includes the *National Nuclear Energy Act* 46 of 1999, *National Nuclear Regulator Act* 47 of 1999, *Hazardous Substances Act* 15 of 1973*, Mine Health and Safety Act* 29 of 1996*, Minerals and Petroleum Resources Development Act* 28 of 2002*, National Environmental Management: Waste Act* 59 of 2008*, National Water Act* 36 of 1998 and the *Dumping at Sea Control Act* 73 of 1980. In 2008 the *National Radio-Active Waste Disposal Institute Act* 53 of 2008 was adopted to provide for the regulation of the disposal of certain types of radioactive waste. The 2008 Act did not rationalise all the laws that regulate radioactive waste,

12 Safety of Radioactive Waste Disposal Proceedings of an International Conference Tokyo, 3–7 October 2005.
13 See par 4 below.
14 IAEA, Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No.GS-R-1, IAEA, Vienna (2000).
15 See par 3.1 and 3.2.
16 See par 3.1.
17 For example the Department of Minerals and Energy: *Radioactive waste Management Policy and Strategy for the Republic of South-Africa* and Department of Environmental Affairs and Tourism *White Paper on Integrated pollution and Waste Management for South Africa* (2000).

although it was foreseen in the *White Paper on Environmental Management*.[18] It is important to determine whether related legislation concerning radioactive waste provides for environmental protection and the protection of human health. Section 24 of the *Constitution of the Republic of South Africa*, 1996 as the cornerstone for environmental governance,[19] should be taken into account as well as the *National Environmental Management Act* 107 of 1998. The *National Road Traffic Act* 93 of 1996 regulates the transport of radioactive waste on South African roads. Various decision-makers govern radioactive waste, environmental and health protection and it seems that fragmentation[20] between different government departments exists pertaining to the regulation of radioactive waste, the environment and health. The latter may create problems for the proper and coordinated handling of radioactive waste.[21]

The aim of the study is to determine whether the South African legislation complies with the international standards in order to address the fragmentation in the regulation of radioactive waste in South Africa. This study is mainly based on literature sources of relevant textbooks, law journals, international documents, case law and internet sources relevant to radioactive waste and the law.

In this study the different types of radioactive waste and the classification of radioactive waste will be discussed as background, followed by a discussion on the environmental impact of radioactive waste.[22] Reference will be made to specific aspects regarding the handling of radioactive waste.[23] The IAEA Standards will be scrutinised[24] as well as the South African legal framework and a comparison

18 Department of Environmental Affairs and Tourism *White Paper on Integrated pollution and Waste Management for South Africa* (2000); see also *Radioactive waste Management Policy and Strategy for the Republic of South-Africa* as discussed in 3.2.
19 S 24.
20 Strydom and King "Environmental Management" 18; Kotzé *Environmental Governance* 110-111.
21 See 5; Strydom and King "Environmental Management" 18; Kotzé *Environmental Governance* 110-111.
22 See 2.1 and 2.7.
23 See 2.5.
24 See 4.

between these standards will be made.[25] The problem of fragmentation is also discussed followed by a conclusion.[26]

2 Background

It is first necessary to determine which types of radioactive waste exist and how these types are classified along with the classification system relating to the classes of radioactive waste, the production and use of radionuclides, the stages of the nuclear fuel cycle, specific aspects regarding the handling of radioactive waste and the environmental impact of radioactive waste are further briefly described as background to this study.

2.1 Different types of radioactive waste and classification

Radioactive waste differs depending on where it is generated, for example, the facility, the concentration of radioactivity, as well as according to its physical and chemical form.[27] To ease the regulation of radioactive waste different methods have been developed to classify radioactive waste according to its physical, chemical and radiological properties.[28] These methods have led to various terminologies that differ from one country to another and even between facilities in the same country. The latter causes various problems regarding communication of waste management practices and comparing data published in the scientific literature. It also causes confusion among members of the public who try to understand radioactive waste management programmes and practices of their country and of other IAEA Member States.[29]

25 See par 5.
26 See par 5.4 and par 6.
27 Handling these different kinds differs from waste to waste and will be discussed later on.
28 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 1; Ahearne *Radioactive waste: The size of the problem* 24-29.
19 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 1.

2.1.1 Purpose of classification

It is necessary to classify radioactive waste in order to regulate its safe handling and disposal. Various classification systems are used, depending on the need for the classification. These methods have led to a range of terminologies that differ between countries and even between facilities in one country. The lack of a uniform classification system also causes problems, for example, regarding communication and a lack of proper communication almost invariably results in misunderstandings and problems. The need for a unified classification system is evident. The advantages of a unified classification system are that it assists in defining radioactive waste management strategies and in organising the waste, by giving a broad indication of the potential hazards involved with the various types of radioactive waste. It also assists by facilitating record keeping and ensures good communication and standards of acronyms that can be universally understood.[30]

Radioactive waste may be classified firstly according to its physical state of nature.[31] This type of classification system is mostly used by individual facilities and assists in these facilities' technical needs and possibilities. It could also incorporate safety considerations, for example, radiation protection that is necessary for radioactive waste classes with higher radioactivity content.[32]

Sometimes the properties of radioactive waste are used as criteria for classification. They include *inter alia* the origin, criticality, radiological properties such as: half-life, heat generation, intensity of penetrating radiation, activity and concentration of radionuclides, surface contamination, and dose factors of relevant radio nuclides. Other physical properties that are taken into account in the radioactive waste are size and weight, compatibility, dispensability, volatility, solubility and miscibility. The chemical properties that are used include amongst others their potential chemical hazard, corrosion resistance/corrosiveness, organic content, combustibility,

30 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 7; Ahearne *Radioactive waste: The size of the problem* 24-29.

31 For example, solid, liquid, gaseous etc.

32 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 7; Ahearne *Radioactive waste: The size of the problem* 24-29.

reactivity, gas generation and absorption of radio-nuclides.[33] Secondly, a widely used qualitative classification system separates radioactive waste into three classes namely low level waste (LLW), intermediate level waste (ILW) and high level waste (HLW) and a further distinction is made between short lived and long lived waste. The latter addresses the following: activity content, radiotoxicity and thermal power. The differentiation between long and short lived radionuclide was established to assist in choosing the appropriate type of repository, which serves essentially the purpose to facilitate international communication.[34]

Thirdly, in most instances the classification of radioactive waste is related to the safety aspects of its management. In this instance it provides a link between the waste characteristics and safety objectives that a regulatory body or the operator of a waste management facility has established. Due to the fact that safety objectives are formulated in general in terms of numerical values, it is necessary to use a quantitative approach to classification.[35]

2.2 Classes of radioactive waste

The classification system relates to the classes of radioactive waste. Waste is classified in high level waste, ILW and low level waste. High level waste is defined as:

> a highly radioactive liquid, containing mainly fission products, as well as some actinides, which is separated during chemical reprocessing of irradiated fuel (aqueous waste from the first solvent extraction cycle and those waste streams combined with it), or any other waste with radioactivity levels intense enough to generate significant quantities of heat by the radioactive decay process, as well as spent reactor fuel, if it is declared a waste.[36]

Intermediate level waste is waste that needs shielding due to its radionuclide content but requires little or no provision for heat dissipation during its handling and

33 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 7; Ahearne *Radioactive waste: The size of the problem* 24-29.

34 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 5; Ahearne *Radioactive waste: The size of the problem* 24-29.

35 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 5.

36 Nathanson *International management of radioactive wastes* 363-380; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 8.

transportation. Low level waste has the same description as intermediate levels of waste, but requires no shielding during normal handling and transportation.[37] The classification relates to individual radionuclides and various exposures and exposure pathways such as inhalation for instance in the case of an incident, or ingestion in the case of long term releases in the post operational period of a repository. Low and intermediate level waste can further be subdivided into short lived and long lived waste (LILW-SL).[38]

> Short lived low and intermediate level waste (LILW-SL) contains low concentrations of long lived radionuclides. The possible hazard represented by the waste can often be significantly reduced by administratively controlling waste as part of storage or after disposal. Although the waste may contain high concentrations of short lived radionuclides, significant radioactive decay occurs during the period of institutional control. Concentrations of long lived radionuclides that will not decay significantly during the period of institutional control are controlled to low levels consistent with the radiotoxicity of the radionuclides and requirements set forth by national authorities.[39]

Short lived waste therefore refers to radioactive waste which will decay to an activity level which is considered to be acceptably low from a radiological viewpoint, within a time period during which administrative controls can be expected to last.

Long lived low and intermediate level waste (LILW-LL) contains long lived radionuclides in such quantities that demand a very high degree of isolation from the biosphere. The latter normally occurs with the disposal in geological formations at depths of several hundred metres:[40]

> Long lived waste is radioactive waste that will not decay to an acceptable activity level during the time which administrative controls can be expected to last.[41]

A universal classification for the boundary between short lived and long lived waste has not yet been established, due to the fact that allowable levels will depend on the

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37 Nathanson *International management of radioactive wastes* 363-380; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 9; Ahearne *Radioactive waste: The size of the problem* 24-29.

38 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 15; Nathanson *International management of radioactive wastes* 363-380.

39 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 15.

40 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 16.

41 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 9.

actual radioactive waste management option and the properties of individual radionuclides.

Sometimes the dosage of radioactivity does not pose a risk.[42] The classification system does not always provide for this types of radioactive material and it was therefore necessary to develop another category namely exemptions.[43] Exempt waste (EW) is waste that contains such a small quantity of radioactive material that it could actually not be seen as radioactive and therefore has to be exempted from nuclear regulatory control. This means that even though the waste is still radioactive from a physical point of view, the waste can be disposed safely by applying conventional techniques and systems, without considering the radioactive properties of the particular waste in essence.[44] The IAEA developed its recommendation system based on research.[45] The fact that individual radiation doses are not of essential importance at these concentrations, makes the radioactive properties of this type of waste less important. Authorities may in certain instances exempt waste higher than those established by the authorised authority.[46] It is therefore necessary to understand the production and use of radionuclides.

2.3 Production and use of radionuclides

The production and use of radionuclides take place during the nuclear fuel cycle and therefore a discussion on the nuclear fuel cycle will be done in the following paragraphs. Radioactive waste is generated by, for example, the use of radionuclides and nuclear power generation, which includes all activities and

42 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 9; Ahearne *Radioactive waste: The size of the problem* 24-29.

43 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 9.

44 Nathanson *International management of radioactive wastes* 363-380; Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 13.

45 They set unconditional clearance levels for radionuclides in solid materials which are based on limiting the annual doses to members of the public to 0.01 mSv. The recommended activity concentrations are dependent on the individual radionuclide and range from about 0.1 Bq/g to about 104 Bq/g.

46 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 13; Ahearne *Radioactive waste: The size of the problem* 24-29.

processes in the nuclear fuel cycle along with other non-fuel-cycle activities.[47] Radioactive waste is also generated outside nuclear activities due to the processing of raw materials that contain naturally occurring radionuclides, such as phosphate ore processing and oil or gas exploration. The radioactive wastes that are generated due to fuel cycle activities exceed the radionuclide content of materials from non-fuel cycle in major prosperity.[48]

The nuclear fuel cycle may be defined as the set of processes and operations needed to manufacture nuclear fuel, its irradiation in nuclear power reactors and storage, reprocessing or disposal of the irradiated fuel.[49] Two different fuel cycle options exist and vary between "open" fuel cycle,[50] and "closed" fuel cycle.[51] The open fuel cycle is the "mode of operation" where the nuclear material is sent through the reactor only once. After irradiation the fuel is stored in "at-reactor pools" until it is transported to "away from reactor storage".

The closed fuel cycle is the "mode of operation" where the spent fuel[52] is reprocessed after a sufficient cooling period in order to extract the remaining uranium and plutonium from the fission products and other actinides. The reprocessed uranium and plutonium is then reused in the reactors.[53] The nuclear-waste cycle is illustrated in figure 1.

47 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 21; Nathanson *International management of radioactive wastes* 363-380.

48 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 21; Nathanson *International management of radioactive wastes* 363-380.

49 Microsoft Encarta Premium Suite 2005 Microsoft Corporation.

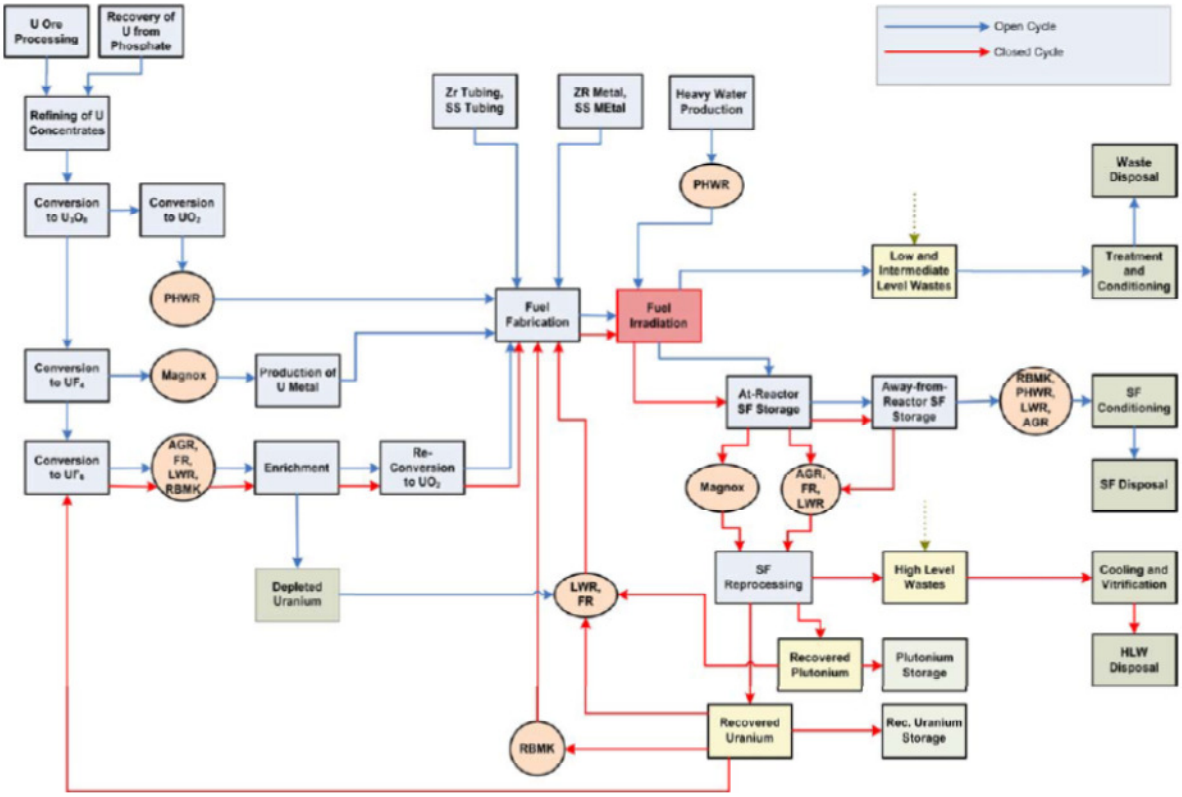
50 Or once-through without reuse of nuclear materials.

51 Microsoft Encarta Premium Suite 2005 Microsoft Corporation; With reuse of nuclear materials extracted from irradiated fuel; www.eoearth.org/article/Nuclear-fuel-cycle.

52 www.eoearth.org/article/Nuclear-fuel-cycle; Microsoft Encarta Premium Suite 2005 Microsoft Corporation; Uranium that are already used.

53 www.eoearth.org/article/Nuclear-fuel-cycle; Microsoft Encarta Premium Suite 2005 Microsoft Corporation; Ahearne *Radioactive waste: The size of the problem* 25-26.

Figure 1: Nuclear fuel cycle[54]



2.3.1 Stages of the nuclear fuel cycle

The nuclear fuel cycle (see figure 1) starts with uranium exploration and ends with disposal of the materials used and generated during the cycle.[55] For practical reasons the nuclear life cycle has been further subdivided into two stages namely the front-end and back-end.[56] The nuclear fuel cycle is completed by the addition of irradiation of nuclear fuel and other related industrial activities to those two main stages. The front-end of the fuel cycle occurs before irradiation and the back-end begins with the discharge of spent fuel from the reactor.[57] The specific steps or processes and the corresponding nuclear fuel cycle facilities can be subdivided in

54 Microsoft Encarta Premium Suite 2005 Microsoft Corporation.
55 Ahearne *Radioactive waste: The size of the problem* 25-26; Microsoft Encarta Premium Suite 2005 Microsoft Corporation; www.eoearth.org/article/Nuclear-fuel-cycle.
56 Microsoft Encarta Premium Suite 2005 Microsoft Corporation; Ahearne *Radioactive waste: The size of the problem* 25-26.
57 Ahearne *Radioactive waste: The size of the problem* 25-26; Microsoft Encarta Premium Suite 2005 Microsoft Corporation; Stoiber *Handbook on Nuclear Law* chapter 5.

front-end, irradiation/nuclear power reactor operation, back-end and related industrial activities.[58]

2.3.1.1Front-end

The front-end processes involve *inter alia* uranium ore exploration that would include activities related to the finding and development of the uranium ores for uranium production. Uranium ore mining is the process of extracting uranium ore from the soil.[59] Further processes of the front-end are uranium ore processing that would include activities related to the milling and refining of the ore in order to produce uranium concentrates including "in-situ leaching" (commonly known as yellow cake) as well as conversion which entails activities related to the refining and conversion to the form which is suitable for any of the other processes followed by enrichment which relate to the isotopic enrichment of UF_6 and uranium fuel fabrication which would entail the production of nuclear fuel to be inserted in the nuclear reactor.[60]

Mostly LLW is generated in this stage of the nuclear fuel cycle where tailings contain long-lived radioactive materials in low concentrations and toxic materials such as heavy metals.[61] It is important to note that the total quantity of radioactivity in this stage is less than in the original ore, and this radioactivity will have a much shorter lifespan than in its original form.[62]

2.3.1.2 Back-end

The back-end processes involve *inter alia* at-reactor (AR) spent fuel storage that would include activities related to the storage of spent fuel in AR spent fuel storage

58 www.eoearth.org/article/Nuclear-fuel-cycle; Microsoft Encarta Premium Suite 2005 Microsoft Corporation; Stoiber *Handbook on Nuclear Law* chapter 5.

59 Stoiber *Handbook on Nuclear Law* chapter 5; Ahearne *Radioactive waste: The size of the problem* 25-26; Microsoft Encarta Premium Suite 2005 Microsoft Corporation.

60 Ahearne *Radioactive waste: The size of the problem* 25-26; Microsoft Encarta Premium Suite 2005 Microsoft Corporation; www.eoearth.org/article/Nuclear-fuel-cycle.

61 Stoiber *Handbook on Nuclear Law* chapter 5; www.eoearth.org/article/Nuclear-fuel-cycle.

62 Ahearne *Radioactive waste: The size of the problem* 25-26; Microsoft Encarta Premium Suite 2005 Microsoft Corporation.

facilities (wet type) for an interim period.[63] Away from reactor (AFR) spent fuel storage is also part of the back-end activities and relates to the storage of spent fuel in AFR spent fuel storage facilities (wet or dry type) for an interim period. The next step is spent fuel reprocessing and recycling and relates to the special treatment of spent fuel to be able to extract the usable materials and to recycle them in the reactors.[64] After reprocessing and recycling, follows the conditioning of the spent fuel. Spent fuel conditioning is an activity related to the production of spent fuel packages which are suitable for handling, transport, storage and disposal.[65] The last step in the nuclear fuel cycle is the disposal of spent fuel which entails the emplacement of spent fuel or waste in an appropriate facility without the intention of retrieval.[66]

Materials and equipment that come into contact with radioactivity are sometimes also regarded as waste. Activity levels may vary between extremely high levels associated with spent fuel and residues from fuel reprocessing to extremely low levels associated with radioisotope applications in for example laboratories and hospitals. The radio nuclides that occur depend on the generating process as well as the source such as naturally occurring, transuranic or specific man-made radionuclides.[67] The production and use of radionuclides are not directly related to nuclear power production and generate much less radioactive waste. Radionuclides are produced, for example, during research activities at research reactors, accelerators, and laboratories. In radioisotope production the type and volume of radioactive waste produced depends on the radioisotope and its production method.[68] The volume of radioactive waste generated from these activities usually has very little quantity, yet specific activities could be significant. The use of radioisotopes will generally generate small quantities of radioactive waste. The type

63 www.eoearth.org/article/Nuclear-fuel-cycle; Microsoft Encarta Premium Suite 2005 Microsoft Corporation.

64 www.eoearth.org/article/Nuclear-fuel-cycle; Microsoft Encarta Premium Suite 2005 Microsoft Corporation; Stoiber *Handbook on Nuclear Law* chapter 5.

65 Ahearne *Radioactive waste: The size of the problem* 25-26; Microsoft Encarta Premium Suite 2005 Microsoft Corporation; Stoiber *Handbook on Nuclear Law* chapter 5.

66 www.eoearth.org/article/Nuclear-fuel-cycle; Stoiber *Handbook on Nuclear Law* chapter 5; Microsoft Encarta Premium Suite 2005 Microsoft Corporation.

67 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 21.

68 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 22; Ahearne *Radioactive waste: The size of the problem* 24-29.

and volume of radioactive waste produced will strongly depend on the application method that is used.[69]

2.4 The decommissioning of nuclear facilities

The decommissioning of a nuclear facility is important due to the health hazard a non-rehabilitated site may pose. The decontamination and dismantling of a nuclear site cause radioactive waste in various types, activity, size and volume. The waste may consist of solid materials, for example, process equipment, construction materials and tools. "To reduce the amount of radioactive waste, decontamination of materials is widely applied."[70]

2.5 Specific aspects regarding the handling of radioactive waste

In order to give effect to the discussion above some safety aspects in terms of the handling of radioactive waste will now be discussed.

2.5.1 Short and long lived waste

Short and long lived radioactive waste have different disposal methods. The packaging is therefore important for the management of this waste. The way in which the waste must be handled varies from simple surface landfills to engineered surface facilities and to disposal at varying depths, normally tens of metres underground, or in deep geological formations depending upon safety analyses and national practices.

It is expected that long lived waste and short lived waste are going to be disposed together in future.[71] Low-level radiation is not dangerous to handle, but must be disposed of more carefully than normal waste. Usually it is buried in shallow landfill sites. To reduce its volume, it is often compacted or incinerated (in a closed

69 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 23.

70 Murray *Understanding radioactive waste* 37.

71 Classification of Radioactive Waste: *A Safety Guide Publication Within The Radwass Programme IAEA* 15.

container) before disposal.[72] Intermediate-level radiation may be solidified in concrete for disposal. Generally short-lived waste (mainly from reactors) is buried, but long-lived waste (from reprocessing nuclear fuel) is disposed of deep underground.[73]

High-level radiation generates a considerable amount of heat and requires cooling, as well as special shielding during handling and transport. If the used fuel is reprocessed, the separated waste is vitrified by incorporating it into borosilicate (Pyrex) glass which is sealed inside stainless steel canisters for eventual disposal deep underground.[74] If used reactor fuel is not reprocessed, all the highly-radioactive isotopes remain, and the fuel assemblies as a whole are treated as high-level waste. This used fuel takes up about nine times the volume of equivalent vitrified high-level waste which is separated in reprocessing.[75] Used fuel treated as waste must be encapsulated ready for disposal. Both high-level waste and used fuel are very radioactive and people handling them must be shielded from the radiation. Such materials are shipped in special containers that prevent the radiation from leaking out and that will not rupture in an accident.[76]

2.6 Liquid and gaseous waste

The main aim for treatment of liquid waste and gaseous waste is to separate the radionuclides from the liquid or gaseous phase and concentrate them into a solid waste form. The separation is continued until the total amount of radionuclides in the liquid or gaseous phase is below limits set by the regulatory body for the discharge of liquid or gaseous waste. Treatment may include a storage period for radioactive decay.[77] Liquid and gaseous radioactive waste that exceed the discharge limits set by national authorities should be conditioned for storage, transport and disposal.[78]

Only after proper safety analysis had been done may radioactive waste in liquid or gaseous form be transported off site of origin and initial disposal in terrestrial

72 Murray *Understanding radioactive waste* 20-35.
73 Murray *Understanding radioactive waste* 25.
74 Murray *Understanding radioactive waste* 70.
75 Murray *Understanding radioactive waste* 13-15.
76 Murray *Understanding radioactive waste* 36.
77 Ahearne *Radioactive waste: The size of the problem* 29.
78 Ahearne *Radioactive waste: The size of the problem* 39

repositories in their original forms. Therefore these forms of waste are much more dangerous to transport than solid forms of radioactive waste and the decay storage at the facility where the waste was generated is part of the conditioning process.[79] Such waste may have a significant impact on the environment as will be discussed in the following paragraphs.

2.7 Environmental and health impacts of radioactive waste

The major concern regarding the release of radioactive substances into the environment is that such substances may harm the environment and the health and safety of people. In most instances it is expected of radioactive producers to limit radiation doses to low levels to ensure that radiation doses to other organisms will also be small and below the levels at which ecological changes might occur. In almost 30 years of nuclear power operations these assumptions have not yet been seriously challenged, but have been studied. Three possible exposure cases for humans and the environment are considered.[80]

It is generally assumed that non-human species will be adequately protected if humans are, and seems at first sight to be reasonable for practices in which radio-nuclides are released into the biosphere in close proximity to human habitation. In these locations environmental concentrations are kept at very low levels in order to keep radiation doses to humans well below dose limits.[81]

It may be an over-simplification to expect that the same low doses would not have an effect on plants and animals.[82] Higher radiation doses can occur due to the soil-to-plant transfer process. This process can lead to the accumulation of radionuclides in plants as well as animals. Higher doses can also result from the special dietary habits of some animals leading to elevated intakes of certain radionuclides. In some instances the greater proximity of plants and animals to radionuclides dispersed in

79 Ahearne *Radioactive waste: The size of the problem* 39.
80 Murray *Understanding radioactive waste* 123.
81 Murray *Understanding radioactive waste* 125-130.
82 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 29; Nathanson *International management of radioactive wastes* 363-380.

soil and water might give rise to higher external radiation doses than what humans would be exposed to when living in the same environment.[83]

When solid radioactive waste is disposed in deep geological formations it forms a series of impermeable barriers around the waste to prevent the migration of radionuclides back to people. If radioactive waste is disposed, it may pose a danger as many disposal facilities are located in environments accessible to plants and animals.[84] Where low-level packaged waste is disposed of into the deep sea it is likelier to question the assumption about the protection of non-human species. Radioactive waste is dumped in extreme depths which cause a large distance between the waste and human life, but it has significant radiation doses that affect deep sea organisms.[85] The doses that reach human populations are at quite acceptable levels, but in this scenario the risk of effects are higher for natural biota than for humans. It is important to note that there is a basic difference in the way that humans view risk to their own species as compared to other species.[86] The effects that radioactive waste may have on the environment will now be discussed.

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83 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 29; Ahearne *Radioactive waste: The size of the problem* 24-29.

84 Nathanson *International management of radioactive wastes* 363-380; Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 29.

85 Ahearne *Radioactive waste: The size of the problem* 24-29; Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 29.

86 As one considers the risk to man, our values are strongly focused upon the individual as of the fact that individuals are considered to have great value and importance, but most other species are viewed and valued more as a type of population than as identifiable individuals. The latter discussion relates to environmental effects regarding the controlled radioactive waste disposal practices and not to environmental impacts which might be caused by accidental releases of radionuclides or due to uncontrolled waste disposal; *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards,* Draft Report; *Effects of Ionizing Radiation on Aquatic Organisms and Ecosystems,* IAEA Technical Reports Series No. 172, Vienna (1976); *Assessing the Impact of Deep Sea Disposal of Low Level Radioactive Waste on Living Marine Resources,* IAEA Technical Reports Series No. 288, Vienna (1988); *Effects of Ionizing Radiation on Aquatic Organisms,* US National Council on Radiation Protection and Measurements, Draft Report 30: It was established that chronic radiation dose rates of 1 milliGray/day (mGy d"1) or less to species in terrestrial ecosystems and 10 mGy d"1 in freshwater ecosystems are unlikely to cause detrimental effects on populations. In the latest study by the IAEA, the maximum radiation dose rates which could be exposed to terrestrial and freshwater organisms as a result of controlled releases of radio-nuclides were conducted by means of simple and conservative calculations. For the evaluation of the impact of controlled releases, the release rates were chosen such that radiation doses to the most exposed human individuals would be equivalent to the annual dose limit for members of the public (1 milliSievert /year). The actual releases to the environment are only a small fraction of these values because of the application of the principle of reducing radiation exposure to as-low-as-reasonably achievable (ALARA).

2.7.1 Releases to atmosphere and surface waters

It is important to note that the available information on the effects of radiation on non-human species is very limited and that the results of these assessments must be treated with caution since they may not be applicable in conceivable situations. In another study that was conducted in response to questions concerning the possible effects on trees and forests when gaseous releases of radionuclides from nuclear power stations take place, it was determined that the radiation doses could only be very small fractions due to natural existing radiation. This means that natural radiation is a major phenomenon which makes it difficult to determine the actual size of the effect of non-natural radiation.[87]

When natural barriers are provided through deep geological location, the wastes are also isolated by various manmade barriers. If migration of radionuclides does occur it would not be in the present time and any radioactivity reaching the biosphere would be at a very low level. The reason for the latter is due to radioactive decay and also due to dilution and retention on surfaces during ground water transport. It is most unlikely that any resulting activity levels would be high enough to cause harm to man or to plants and animals.[88]

The near-surface disposal in the terrestrial environment needs a much lesser degree of isolation than in the case of deep geological disposal, which means that the possibility exists that some disposal sites may be intruded by plants and animals. There is evidence that the disposal of unpackaged waste may result in the occurrence of flooding due to improper citing or due to inadequate drainage.[89] This could cause radionuclides to spread beyond the zone of the disposal trench, downwards into the soil and could end up in local streams and groundwater systems. New technology of near-surface disposal facilities reduces the risk of intrusion by

87 *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards,* Draft Report.

88 Shallow land burial of low-level radioactive wastes in the USA, IAEA-SM-243/152 (1980) 30.

89 Shallow land burial of low-level radioactive wastes in the USA, IAEA-SM-243/152 (1980) 30; Phillips and Lin http://nwulib.nwu.ac.za.

plants, animals or even humans due to the fact that the wastes are encapsulated and then stored within concrete barriers.[90]

According to IAEA studies some older disposal sites have much higher radionuclide concentrations than those sites that currently exist. In more modern engineered disposal sites containing radioactive waste in encapsulated forms, the impact on plants and animals seem to be much localised in space which causes only a small fraction of animal and plant populations to be exposed to radiation from such a site.[91]

In the instance where humans get into physical contact with radioactive waste, negative effects such as burns, cancers, and death might occur.[92] Although exposure to small amounts of radiation may cause some detectable changes in human blood, small doses normally do not have immediate harmful effects. Higher doses of radiation exposure cause radiation sickness which includes first signs such as nausea, vomiting, headache and some loss of white blood cells.[93]

Exposure to even higher doses of radiation causes *inter alia* temporary hair loss and more significant internal harm, that would include damage to nerve cells.[94] This exposure furthermore causes extreme damage to white blood cells, which makes humans exposed to radiation more vulnerable to diseases.[95] The latter occurs due to the fact that white blood cells are the body's main defence mechanism against infection. Radiation furthermore strains the production of "blood platelets" that prevent blood clotting.[96] This causes people exposed to higher levels of radioactive waste to be more vulnerable to haemorrhage.[97]

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90 Shallow land burial of low-level radioactive wastes in the USA, IAEA-SM-243/152 (1980) 30.
91 Classification of Radioactive Waste: *A Safety Guide Publication within The Radwass Programme IAEA* 31.
92 http//:www.pub.iaea.org/MTCD/publications/PDF/Pub989e-scr.pdf.
93 Comte and Herald *Radioactive waste: What health effects or risks*; www.pub.iaea.org; http//:www.reachingcriticalwill.org/technical/factsheets/health.html.
94 Albrecht, Amey and Amir *The siting of Radioactive Waste Facilities and the effects on Communities*; http//:www.pub.iaea.org/MTCD/publications/PDF/Pub989e-scr.pdf.
95 http//:www.pub.iaea.org/MTCD/publications/PDF/Pub989e-scr.pdf.
96 http//:www.reachingcriticalwill.org/technical/factsheets/health.html.
97 Shallow land burial of low-level radioactive wastes in the USA, IAEA-SM-243/152 (1980) 30; http//:www.pub.iaea.org/MTCD/publications/PDF/Pub989e-scr.pdf.

When humans are exposed to even higher doses of radiation death becomes more of a reality.[98] Other symptoms that occur together with the symptoms mentioned above are fever and diarrhoea. There is no effective treatment for radiation exposure which means that people exposed to higher levels of radiation may die within a few days or weeks. If it happens that such a person survives he/she will face various diseases that may include *inter alia* "leukaemia,[99] lung cancer; thyroid cancer and breast cancer."[100] Cancers of other organs may also appear due to the radiation exposure. Other negative effects of radioactive waste on humans include *inter alia* "birth defects, genetic damage and lowered immunity to diseases."[101]

Harmful effects of radioactive waste on the environment include the loss of vegetation and plant life, loss of animal life, and over time the mutations of species.[102] Radioactive waste can affect ecosystems and could change biomes; streams situated close to a site can be contaminated with radioactivity; ground water can also become contaminated and sterilisation of land can occur when large volumes of radioactive waste are disposed on the land.[103] The utilisation of that land is then limited to open spaces no longer suitable to be used for agricultural purposes.

The effects that radioactive waste have on human health and the environment, necessitates regulation.[104] Internationally certain principles developed that underpin radioactive waste regulation.[105] These principles will now be discussed.

98 http//:www.reachingcriticalwill.org/technical/factsheets/health.html.
99 Or blood cancer; www.reachingcriticalwill.org/technical/factsheets/health.html.
100 Albrecht, Amey and Amir *The siting of Radioactive Waste Facilities and the effects on Communities*; http//:www.reachingcriticalwill.org/technical/factsheets/health.html.
88 http//:www.pub.iaea.org/MTCD/publications/PDF/Pub989e-scr.pdf.
102 http//:www.pub.iaea.org/MTCD/publications/PDF/Pub989e-scr.pdf; see also Birne, Boyle and Redgwell *International Law and the Environment* 335-377.
103 Fiehn and Ball *Integrated Waste Management* 2-3.
104 Linsley and Tonhauser *An Expanding International Legal Regime* 24.
105 Scholtz *Different countries, one environment* 120; Linsley and Tonhauser *An Expanding International Legal Regime* 24.

3 Principles

The Precautionary principle along with the life cycle management; waste minimisation, disposal and treatment; the polluter pays principle and the principle of co-operative governance will be discussed as they are imperative regarding the regulation of radioactive waste. Other important principles such as the principle of transparency; the principle of sound decision-making and the principle of public participation along with the principle of capacity building and education are also included in this discussion of environmental principles.

3.1 Precautionary principle

The precautionary principle focuses mainly on "safety and caution." According to Hey[106] this principle requires "preventive action" before any harm has been done or could be done. It may also prevent action that will cause irreparable harm to the environment from taking place.[107]

The precautionary principle is a "policy-making strategy" that influences the manner in which policy-makers protect the environment, by means of "science, technology and economics."[108] In terms of the precautionary principle, states need to take sufficient steps in order to "control and regulate" sources that may cause extreme "global environmental pollution or transboundary harm" within their jurisdiction.[109] Radioactive waste is a by-product of industry and mining and cannot be prevented. However, in such a case the precautionary approach should be applied conservatively as Yield states:

> A highly conservative approach- "Precautionary Principle"- to pollution must be adopted by industry and government by minimising, and wherever possible preventing, the discharge of harmful substances. A "cradle to grave" approach should be applied to reduce or eliminate pollution at all stages of production, instead of concentrating only on cleaning-up operations at the "end of pipe".[110]

106 McIntyre and Mosedale *the Precautionary Principle* 222; see also Birne, Boyle and Redgwell *International Law and the Environment* 335-377.

107 Kidd *Environmental Law* 57.

108 McIntyre and Mosedale *the Precautionary Principle* 222; Verschuuren *Principles of Environmental Law* 51-72.

109 This principle was first articulated in the Trail Smelter Arbitration of 1941 between Canada and the United States; see Linsley and Tonhauser *An Expanding International Legal Regime*24.

110 Yeld J *Caring for the earth South Africa: A strategy for Sustainable living chapter* 4.

This principle states that where threats of serious irreversible damage to the environment occur, the lack of scientific evidence regarding the environmental threat cannot be used as a reason for the postponement of measures to prevent environmental degradation. This is also stated in the *Rio-declaration* in Principle 15,[111] and applicable to the regulation of radioactive waste in South Africa.[112] The precautionary principle is an international environmental principle incorporated into South African law and therefore needs to be applied in the context of radioactive waste regulation.[113] The precautionary principle as well as the other applicable principles that will be discussed later on are to be seen in various international treaties such as the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.[114]

3.2 Life cycle management

Chapter 21 of Agenda 21[115] provides that environmentally sound waste management must go beyond the mere safe disposal or recovery of waste. It must also attempt to address the cause of the problem by changing unsustainable patterns of production and consumption.[116] Due to the fact that Agenda 21 is a comprehensive plan of action to be taken globally, nationally and locally by organisations of the United Nations System, governments, and major groups in every area in which humans exercise an impact on the environment, these principles should be taken into account in terms of regulation of radioactive waste in South Africa.[117]

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111 Strydom and King "Environmental Management" 139; Department of Minerals and Energy *Radioactive waste Management Policy and Strategy for the Republic of South-Africa* 9.

112 See also National Climate Change Response Green paper 2010 5-6.

113 See section 2(4)(a)(vii) of NEMA.

114 See in general Linsley and Tonhauser *An Expanding International Legal Regime* 24; see also Scholtz *Different countries, one environment* 120; Verschuuren *Principles of Environmental Law* 51-72.

115 The United Nations Conference on Environment and Development (UNCED) was held in Rio De Janeiro in 1992. Known as "The Earth Summit", the conference managed to reach accord on two international agreements, two statements of principles and a 'blueprint' for global sustainable development named Agenda 21.

116 S 21(4).

117 http://www.un.org; see also NEMA s 2(4)(a)(e).

3.3 Waste minimisation, disposal and treatment

Agenda 21 acknowledges that the framework for the necessary action must be based on a "hierarchy of objectives" and ought to focus on "the four major waste-related programme areas"[118] which are the minimisation of waste; the maximising of environmentally sound waste re-use and recycling; promoting environmentally sound waste disposal and treatment and extending waste service coverage.[119] The first three areas identified by the UNCED[120] correlate with the conventional view regarding the three fundamental objectives of waste management which are the avoidance of waste production; the reduction of such waste as cannot be avoided as well as the disposal of the residue in an environmentally acceptable and safe manner.[121]

Regardless of the fact that the focus is on waste management, these objectives correlate with the overall objective of pollution control in South Africa[122] and any assessment of the effectiveness of a pollution control law must be conducted in the light of these mentioned objectives.[123] The regulation of radioactive waste in South Africa is therefore also included and need to be regulated according to these objectives of Agenda 21.

3.4 Polluter pays principle

The polluter pays principle is an international environmental principle incorporated into South African legislation.[124] The polluter pays principle stipulates that the entity that is responsible for environmental harm is also responsible for the costs to rehabilitate the affected environment. In other words the financial burden for the management of radioactive waste rests on the generator of that waste. This is an economic principle that requires the internalisation of externalities and is compatible

118 S 21(5).
119 S 21(5).
120 See vn 111.
121 Department of Environmental Affairs and Tourism *White paper on Integrated pollution and Waste Management for South Africa* (2000) 18.
122 See NEMA s 2(4)(a)(iv).
123 Kidd *Environmental Law* 144.
124 See also National Climate Change Response White Paper 2011 5-6; NEMA s 2(4)(a)(p).

with corrective justice as of the fact that it serves as a reparative function.[125] This principle is applicable when pollution occurs and it stands to reason that radioactive waste pollution will be a priority on any list. Waste management in South Africa should be managed according to the polluter pays principle.[126]

3.5 Principle of co-operative governance

Co-operative governance as well as efficient national co-ordination is important for regulating radioactive waste in South Africa. Activities involving radioactive waste management are of a crosscutting nature and proper governance and co-ordination would ensure that management takes place in such a way as would maximise effective efforts and as would prevent duplication of effort.[127] There are three spheres of government that are established by the Constitution, namely National, Provincial and Local government.[128] These spheres of government are "distinctive, interdependent and interrelated" and all of them have environmental responsibilities.[129] National Government along with all other spheres has responsibilities in terms of the Constitution and the Bill of Rights, while Provincial Government has certain concurrent legislative and executive powers with National Government on issues of the environment. Local Government, is for example, instructed to "promote a safe and healthy environment."[130]

South Africa does not have a single environmental authority, although the *White Paper on Environmental Management* proposed such an authority. MacKay and Ashton state the following with regard to co-operation on national level:

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125 UN *Framework Climate Change Convention* of 1992.

126 The principles provided for in the *National Environmental Management Act* 107 of 1998 apply throughout the country and bind all organs of state (NEMA s 2); Strydom and King "Environmental Management" 717-719; Department of Minerals and Energy *Radioactive Waste Management Policy and Strategy for the Republic of South-Africa* 9; Due to the extent of this dissertation the principles cannot be discussed in detail, for more information see: Sands *Principles of International Environmental Law (*2003) 618-674.; Verschuuren *Principles of Environmental Law* 51-72; Scholtz *CILSA* 166-182; Strydom and King "Environmental Management" 18; Department of Minerals and Energy *Radioactive waste Management Policy and Strategy for the Republic of South-Africa* 9.

127 Strydom and King "Environmental Management" 204; Department of Minerals and Energy *Radioactive Waste Management Policy and Strategy for the Republic of South-Africa* 9.

128 Bekink *Principles*1.

129 Du Plessis *Legal Mechanisms* 4.

130 Section 152(1); see also Du Plessis *Legal Mechanisms* 4; Rautenbach and Malherbe *Staatsreg* 294-299; Currie I and De Waal J *The new Constitutional & Administrative Law* 119-121.

> At the level of national Government, the new principles, policies and legislative instruments in each sector appear to be aligned closely with and fully support, the key principles embodied in the Constitution … However, the clear separation of line functions between different Government departments (e.g. water, agriculture, housing, etc.) makes it difficult to attain proper levels of alignment and coherence between these different functions, as each department operates independently within its area of mandate.[131]

Chapter 3 of the Constitution is imperative in terms of the principle of co-operative governance and determines that if an issue is related to environmental matters (such as radioactive waste), the departments dealing with different aspects of the environment must co-operate with one another in good faith and co-ordinate their actions and legislation with one another.[132] In order to emphasise the importance of co-operative governance regulation 3 of GN 709,[133] issued in terms of the National Nuclear Regulator Act,[134] determines that the National Nuclear Regulator of South Africa and each relevant organ of state, must produce a "draft co-operative agreement" in respect of each of the following objectives of co-operative governance for:

> ensuring the effective monitoring and control of the nuclear hazard; co-ordinating the exercise of such functions; minimising the duplication of such functions and procedures regarding the exercise of such functions; and promoting consistency in the exercise of such functions.

Co-operation is extremely important in the South African context in terms of environmental governance and therefore for the sound regulation of radioactive waste. There are also other principles applicable to the regulation of radioactive waste in South Africa and these will be briefly discussed in the following paragraphs.

3.6 Other principles

The principle of transparency in terms of all aspects of radioactive waste management determines that all radioactive waste management activities must be

131 MacKay and Ashton *Towards cooperative governance* 3; Du Plessis *Legal Mechanisms* 5.
132 Constitution s 41(h); NEMA s 2(4)(a)(l).
133 GG 23428 of 24 May 2002 regarding Co-operative Governance in Respect of the Monitoring and Control of Radioactive Material or Exposure to Ionising Radiation.
134 See s 6.

conducted in an open and transparent manner.[135] The principle further includes that the public has access to information regarding waste management where this does not infringe on the security of radioactive material.[136] The principle of sound decision-making based on scientific information, risk analysis and optimisation of resources determines that the decision-making must be based on proved scientific information as well as recommendations of competent national and international institutions who deal with radioactive waste management.[137]

Of further importance is the principle of public participation that determines radioactive waste management must, when decisions are taken, consider the interests and concerns of all interested and affected parties.[138] Last, but not least, is the principle regarding capacity building and education. According to this principle the government must create opportunities to develop people's understanding, skills and general capacity concerning radioactive waste management and must use these principles to develop, test and apply its policy. This principle also states that government must use the principles for decision-making and where necessary amend legislation and regulations.[139]

It is also necessary to describe the standards set by the IAEA regarding the regulation of radioactive waste in order to determine whether South African legislation complies with the standards of the IAEA.

4 IAEA Standards

4.1 Introduction

The IAEA was established in 1957 with the objective of promoting the use of atomic energy for peaceful activities, health, and prosperity throughout the world.[140] In terms

135 See NEMA s 2(4)(a)(k).
136 Department of Minerals and Energy *Radioactive waste Management Policy and Strategy for the Republic of South-Africa* 9.
137 Department of Minerals and Energy *Radioactive waste Management Policy and Strategy for the Republic of South-Africa* 9.
138 See NEMA s 2(4)(a)(f).
139 Department of Minerals and Energy *Radioactive waste Management Policy and Strategy for the Republic of South-Africa* 9.
140 See also 1; Linsley and Tonhauser *An Expanding International Legal Regime* 29.

of radioactive waste, the IAEA established standards for the protection of human health and the environment against radiation exposure from radioactive waste and to provide for the application of these standards.[141] The IAEA is commonly known under various conventions as the "lead international organisation" for developing the "clearinghouse mechanism" for radioactive substances.[142]

The fact that radioactive waste is an extreme hazard to the environment and humans requires it to be managed in such a manner as would avoid exposure to these elements.[143] This places pressure on the current generations to establish a safe and sound manner to address and manage radioactive waste that must be applied to the whole life cycle of waste management, from waste generation to waste disposal.[144] A management system should provide sound measures to address technical issues that relate to *inter alia* safety, protection of health, protection of the environment, security, quality and economics. These aspects are addressed in the IAEA Safety Guide where the aim is:

> to provide recommendations on developing and implementing management systems for the pre-treatment, treatment, conditioning and storage of radioactive waste. The Safety Guide covers the management systems for the pre-treatment which include the collection, segregation, chemical adjustment and decontamination; treatment volume reduction, removal of radioactive material and change of composition; conditioning immobilisation, packaging and over packing along with storage of radioactive waste.[145]

Adequate care must be taken to ensure that control of radioactive waste and waste management activities in the established system will be taken on a continued basis and to ensure that the relationships between all the organisations involved are

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141 IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000); Linsley and Tonhauser *An Expanding International Legal Regime* 29.

142 Linsley and Tonhauser *An Expanding International Legal Regime* 29; IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000).

143 See principles as discussed in 3.

144 IAEA *Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations*, Code and Safety Guides Q1–Q14, Safety Series No 50-C/SG-Q IAEA; The term management system is used instead of quality control which reflects on the evolution in the approach from the initial concept of *quality control* through *quality assurance* and *quality management*. The management system is the set of interrelated or interacting elements that establishes policies and objectives and that enables those objectives to be achieved in a safe, efficient and effective way.

145 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.

maintained.[146] It is necessary to remember that managing waste has long term safety, health, environmental, security, quality and economic implications and the present generation must assume responsibility for the related procedures. The next generations will inherit the existing conditions as well as the responsibility to manage the waste and with the associated processing, handling, storage or disposal facilities. Furthermore it is important that the management system be sustainable throughout and with all aspects taken into account.[147] With these aspects mentioned above in mind a discussion of some of the most important aspects will be presentedin the following paragraphs.

4.2 Handling of and dealing with radioactive waste to protect human health and the environment

The requirements established by the IAEA for the protection of human health and the environment apply to the predisposal management of radioactive waste.[148] Activities in the predisposal management of radioactive waste contribute to ensure that radioactive waste is dealt with in a manner that protects human health and the environment at present and in future, without imposing undue burdens on future generations.[149] In the design of a facility and the planning of practices for the predisposal management of radioactive waste it is required to take into account the need to protect both workers and the public against exposure to radiation in accordance with the Basic Safety Standards,[150] which require that occupational doses be kept below established dose limits and as low as reasonably achievable (ALARA), with economic and social factors being taken into account.[151]

146 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 27.

147 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 27.

148 IAEA, Predisposal Management of Radioactive Waste, Including Decommissioning, Safety Standards Series No WS-R-2 IAEA Vienna (2000).

149 IAEA The Principles of Radioactive Waste Management, Safety Series No 111-F Vienna (1995).

150 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management INFCIRC/546 IAEA Vienna (1997).

151 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management INFCIRC/546 IAEA Vienna (1997) s 2.

Owing to the high radionuclide concentrations and high radiation levels associated with radioactive waste, its predisposal management has the potential to give rise to significant exposure to radiation of workers and members of the public. The emphasis must therefore be placed on the prevention, detection and mitigation of incidents and accidents in the design, operation and decommissioning.[152] Careful attention must also be paid to the control of occupational exposure in the design of a facility and in operational practices for the predisposal management of radioactive waste.[153] Doses due to occupational exposure must be maintained ALARA by means of sound operational and engineering practices and administrative controls. Examples of such measures include the following:

> Thorough planning for and careful execution of activities for the management of radioactive waste, including facilitating the eventual decommissioning of management facilities for radioactive waste; pre-work assessments and training mock-up's to minimise exposures during operational and maintenance activities; the use of remote handling technologies for operational and maintenance activities; establishing controls, such as activity limits, if items are transferred or removed from areas of higher contamination to areas of lower contamination.[154]

Releases of radioactive material to the environment from predisposal management facilities for radioactive waste must be controlled in accordance with the recommendations provided in IAEA *Regulatory Control of Radioactive Discharges to the Environment, Safety Standards* Series[155] and the limits and conditions set by the regulatory body. The adequacy of controls provided to limit the exposure of workers and the public must, where appropriate, be verified by means of personal, area and discharge monitoring.[156] Decision-making on the reprocessing or direct disposal of spent fuel must be postponed if no disposal facility is available. Programmes must be undertaken in such a manner that the generation of liquid radioactive waste and the need for its long term storage are minimised to the extent practicable.[157]

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152 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.

153 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.

154 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.

155 No WS-G-2.3 IAEA Vienna (2000).

156 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.

157 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.

"The generation of radioactive waste shall be kept to the minimum practicable, in terms of both its activity and volume…"[158] Minimising the generation of radioactive waste, must be a goal of the process in which it is generated. It must be a general goal to reduce the volume and activity of the secondary waste streams that can arise from the management activities. According to the IAEA the elements that must be considered for reducing the amounts of such waste generated include the use of a "well-designed process, efficient operations and a well-conceived and executed decommissioning of the facility."[159] A safety culture is required in all organisations involved in the predisposal management of radioactive waste, from its generation to its eventual disposal. This is necessary to encourage an enquiring, learning and self-disciplined outlook regarding protection and safety and to discourage complacency.[160] Safety aspects will now be discussed in more detail.

4.3 Safety assessment

The importance of the safe management of radioactive waste for the protection of human health and the environment is fairly well known. The principles and requirements that govern the safety of the management of radioactive waste are presented in the Principles of Radioactive Waste Management,[161] Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety[162] and Predisposal Management of Radioactive Waste, including Decommissioning.[163]

158 IAEA The Principles of Radioactive Waste Management, Safety Series No 111-F IAEA Vienna (1995) par 324.

159 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.

160 Food and Agriculture Organisation of the UN IAEA International Labour Organisation OECD Nuclear Energy Agency, Pan American Health Organisation, World Health Organisation, international Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No 115 IAEA Vienna (1996) par 2.28; International Nuclear Safety Advisory Group, Safety Culture, Safety Series No 75-INSAG-4 IAEA Vienna (1991).

161 IAEA The Principles of Radioactive Waste Management, Safety Series No 111-F IAEA Vienna (1995).

162 IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000).

163 IAEA, Predisposal Management of Radioactive Waste, Including Decommissioning, Safety Standards Series No WS-R-2 IAEA Vienna (2000).

This IAEA Safety Guide provides recommendations on how to meet the safety requirements for the predisposal management of high level radioactive waste, which includes HLW in liquid form and solidified form from the reprocessing of spent fuel and also spent fuel itself, if declared as waste. The predisposal management of radioactive waste includes all the steps in the management of waste prior to its disposal and also includes decommissioning.[164] This Safety Guide of the IAEA provides recommendations to regulatory bodies and other national authorities and operating organisations (operators) on the safe processing of waste and guidance on the properties necessary for waste packages to meet the requirements for handling, transport, storage and disposal.[165] Meeting these requirements will ensure proper planning for and the safe management of HLW in the established nuclear regulatory framework.

Safety assessments are required to be prepared for facilities and activities for the predisposal management of HLW, including decommissioning activities, to demonstrate that the basis for safety is adequate and, more specifically, that such facilities and activities will be in compliance with the safety requirements established by the regulatory body.[166] The safety assessment must also demonstrate that the packages for HLW will sufficiently confine the waste in normal operations and in postulated incidents and accidents.[167]

A safety assessment is required prior to the construction and operation of a facility for the predisposal management of HLW to demonstrate that the facility will provide adequate margins of safety for workers and the public in normal operations and in postulated incidents and accidents.[168] If required by national legislation, an environmental impact assessment must be conducted to demonstrate that the anticipated environmental impacts of the construction, operation and

164 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.
165 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.
166 IAEA Predisposal Management of Radioactive Waste, Including Decommissioning, Safety Standards Series No WS-R-2 IAEA Vienna (2000) par 5.3.
167 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.
168 IAEA Predisposal Management of Radioactive Waste, Including Decommissioning, Safety Standards Series No WS-R-2 IAEA Vienna (2000) par 5.3.

decommissioning of the facility comply with the regulations issued by the appropriate national authority. A safety assessment for a facility for the predisposal management of HLW must, as a minimum, address the following topics:

> The specification of relevant safety criteria; methods for the identification, collection and evaluation of data and information; the specification of normal and abnormal operating conditions; the determination of potential consequences of normal operations and abnormal events; an assessment of the potential consequences of normal operations and abnormal events on the basis of safety criteria.[169]

In the context of regulation of radioactive waste there are certain responsibilities on the side of both the regulator and the operator which will be discussed in the following paragraph.

4.4 Roles and responsibilities of the regulator and operators

The predisposal management of radioactive waste is required to take place within an appropriate national legal framework that provides a clear allocation of responsibilities,[170] and effective regulatory control of the facilities and activities involved.[171] The national legal framework must permit compliance with other national and international laws. Although laws are normally of a general nature, the national legal system may permit the issuing of site specific regulations for the predisposal management of radioactive waste. Requirements in respect of the responsibilities for establishing such a framework and the responsibilities of the regulatory body for ensuring the safety of the predisposal management of radioactive waste are established in the IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety.[172]

The predisposal management of radioactive waste may involve the transfer of radioactive waste from one operator to another or the processing of radioactive

169 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3.

170 IAEA The Principles of Radioactive Waste Management, Safety Series No 111-F IAEA Vienna (1995).

171 IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000); IAEA Predisposal Management of Radioactive Waste, Including Decommissioning, Safety Standards Series No WS-R-2 IAEA Vienna (2000) par 3.5-3.9.

172 Safety Standards Series No GS-R-1 IAEA Vienna (2000).

waste in another state. The legal framework must include provisions to ensure that there is a clear allocation of responsibility for safety during the entire predisposal management process including any transfer between operators.[173] Consideration must also be given to the decommissioning of any facility at which radioactive waste is generated. This continuity of responsibility for safety must be ensured by means of appropriate authorisations by the regulatory body, for example, by a licence or a sequence of licences, in accordance with the national legal framework and agreements among the states involved in the transboundary movement of radioactive waste.[174] An individual governmental organisation must not be given both operational and regulatory responsibility for radioactive waste management. However, if this cannot be avoided, the regulatory and the operational responsibilities must be clearly specified and functionally separated.[175]

4.4.1 Responsibilities of the regulatory body.

For the predisposal management of radioactive waste, the regulatory body must act within the national legal framework, to establish policies, safety principles and associated criteria and to establish requirements to serve as the basis for its regulatory actions.[176] In fulfilling its obligations the regulatory body is required to carry out a number of the functions that are established in the IAEA, *Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety*, with the primary ones being:

> To review and assess submissions on safety from the operators; to issue, amend, suspend or revoke authorisations; to carry out regulatory inspections; to ensure that corrective actions are taken if unsafe or potentially unsafe conditions are detected and to take the necessary enforcement action in the event of a violation of the regulatory requirements.[177]

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173 IAEA The Principles of Radioactive Waste Management, Safety Series No 111-F IAEA Vienna (1995).

174 See also principles as discussed in par 3; IAEA The Principles of Radioactive Waste Management Vienna (1995).

175 IAEA The Principles of Radioactive Waste Management Safety Series No 111-F IAEA Vienna (1995); IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000) par 3.1 and 3.2; see also 5.2.1.6 to 5.2.1.8 for position in South Africa.

175 Safety Standards Series No GS-R-1 IAEA Vienna (2000).

176 IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000) par 3.1 and 3.2.

177 Safety Standards Series No GS-R-1 IAEA Vienna (2000).

The operator must follow such guidelines in selecting design options and operating practices to facilitate decommissioning.[178] Due to the potentially long time periods between the conditioning of radioactive waste and its disposal, particular attention must be drawn to ensure that the necessary human, technical and financial resources will be available when required and that the appropriate information is available.[179] The regulatory body must ensure that a structure for obtaining the resources is in place and that the necessary records are prepared and maintained for an appropriate period of time.[180] The regulatory body must typically provide guidance to the operators carrying out the predisposal management of radioactive waste on as stated below:

> Criteria for the protection of human health and the environment; requirements for nuclear safety; requirements for the control of effluent discharges; criteria for the characterisation and classification of radioactive waste; strategies for the management of radioactive waste; acceptance criteria for the long term storage and/or disposal of radioactive waste; processes and procedures for the granting of a licence or another type of authorisation; procedures for the modification of plant or procedures; policies and procedures used by the regulatory body for verifying compliance and enforcement; the timing and content of periodic reports to be submitted by the operator to the regulatory body; safety culture and quality assurance.[181]

According to the standards of the IAEA the regulatory body must verify the key aspects of operations for the predisposal management of radioactive waste to be performed by the operator, for example, the compliance of the conditioned radioactive waste package with the acceptance requirements of the disposal facility or long term storage facility.[182]

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178 Conditioning involves the conversion of liquid HLW into a solid waste form, the enclosure of the solidified waste in containers (typically called canisters) and, as required, the placement of the containers into an over pack for storage or disposal. The solidified waste form, together with any containers is generally described as a waste package, this waste package should be in a form suitable for disposal. The requirements for materials and the structural requirements for containers should be based on the known or expected requirements for acceptance for disposal. The waste package should be designed to ensure safety in handling, transport and storage.

179 IAEA The Principles of Radioactive Waste Management Safety Series No 111-F IAEA Vienna (1995).

180 IAEA, Documentation for Use in Regulating Nuclear Facilities, Safety Standards Series No GS-G-1.4 IAEA Vienna (2002).

181 IAEA The Principles of Radioactive Waste Management, Safety Series No 111-F IAEA Vienna (1995).

182 IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000) par 3.3 and 3.6.

Further responsibilities of the regulatory body in terms of disposal would include *inter alia*, that the regulatory body must establish regulatory requirements for the development of different types of disposal facilities for radioactive waste and would need to determine the processes to comply with the requirements for the different stages of the licensing process.[183] It must also determine conditions for the development, operation and closure of each individual disposal facility and must conduct these activities as required to ensure that the conditions are met.[184]

4.4.2 Responsibilities of the operators

Before construction or significant modification of a facility for the predisposal management of radioactive waste can be done, the operator must submit to the regulatory body an application detailing the proposed design and operational practices together with a safety assessment, in accordance with regulatory requirements.[185] This submission must justify the proposed practices and must demonstrate their safety by means of an assessment as described in section 7.[186] Prior to the regulatory body's granting of an authorisation to commence operations using radioactive material, the operator must conduct pre-operational and commissioning tests in order to show compliance with the requirements for design and other safety requirements.[187]

The operator may process, store and/or dispose radioactive waste in an approved manner by using its own facilities or may transfer waste at some point to another operator. In so doing, the operator must identify suitable destinations and must ensure that any transfer of radioactive waste is made only to authorised organisations. It is the responsibility of the operator to ensure that radioactive waste

183 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 18.

184 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 18.

185 IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000) s 5.

186 Of the IAEA Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Standards Series No GS-R-1 IAEA Vienna (2000).

187 IAEA The Principles of Radioactive Waste Management, Safety Series No 111-F IAEA Vienna (1995).

is transported safely and in accordance with national and international regulations for the safe transport of radioactive material.[188]

The operator is the responsible person for the safety of all activities in the predisposal management of waste, even if the work is done by a third party. Any transport of waste to other states must comply with international obligations such as Article 27 of the *Joint Convention on the Safety of Spent Fuel Management* and on the Safety of Radioactive Waste Management.[189] The provisions of the *Basel Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal* and the *Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Waste Within Africa* are also imperative in this regard.[190]

The operator has full responsibility for ensuring that the waste packages comply with the acceptance requirements for disposal. The operator must also prepare plans for decommissioning activities and emergency management and must put in place mechanisms to ensure that financial resources are sufficient to undertake all tasks throughout the lifetime of a facility.[191] There must be adequate communication among all parties to ensure the effectiveness and efficiency of the overall system. The regulator and the operator are therefore responsible for the control of waste generation which will be discussed next.[192]

4.4.3 Control of waste generation

The generation and production of radioactive waste is an unavoidable result of operating a nuclear power plant. The latter occurs regardless of the form of radioactive waste such as liquid waste as the result of the reprocessing of spent fuel

188 IAEA Regulations for the Safe Transport of Radioactive Material 1996 Edition (Revised) Safety Standards Series No TS-R-1(ST-1, Revised) IAEA Vienna (2000).

189 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management INFCIRC/546 IAEA Vienna (1997).

190 See Department of Minerals and Energy: *Radioactive waste Management Policy and Strategy for the Republic of South-Africa* where it is determined that South Africa will not import or export radioactive waste.

191 IAEA Predisposal Management of Radioactive Waste, Including Decommissioning, Safety Standards Series No WS-R-2 IAEA Vienna (2000).

192 IAEA The Principles of Radioactive Waste Management, Safety Series No 111-F IAEA Vienna (1995).

or in the form of spent fuel itself. The principle of keeping the volume of waste to the minimum is an imperative factor that must be taken into account in the selection of approaches regarding storage and processing, in order to minimise the generation of secondary forms of waste.[193]

For a conditioning process in which components become contaminated, for instance a smelter, the verification of radioactive waste equipment of proven longevity must be used. For the qualification of a conditioning process the programme must be designed in such a manner that the number of "test specimens" using actual radioactive waste is minimised.

Due to the fact that "reduction at source" is the most efficient way of keeping the amount of radioactive waste generated to the minimum, practicable facilities for the predisposal management of radioactive waste must be designed and implemented.[194] In order to effectively achieve the aspects discussed in the context of radioactive waste regulation the people working with this waste must be properly qualified.

4.4.4 Qualification of staff

Operating staff must be qualified according to the requirements of the regulatory body for the performance of their tasks. Members of staff who are responsible for the operation of facilities in which radioactive waste is generated must undertake a specified training programme that will ensure that they understand the processes involved and the interrelationships of all stages in the process of waste management as well as the consequences of operator error for safety and the generation of waste.[195] Without such knowledge, for example, a waste package could be produced

193 Examples of processing steps in which this principle must be taken into account include: the selection of conditioning processes and the testing programme invoked to verify treatment and conditioning processes.

194 IAEA Predisposal Management of Low and Intermediate Level Radioactive Waste, Safety Standards Series No WS-G-2.5 IAEA Vienna (2003).

195 IAEA *Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations*, Code and Safety Guides Q1–Q14 Safety Series No 50-C/SG-Q IAEA.

that would not meet the acceptance criteria for subsequent processing, storage or disposal or that could pose a hazard.[196]

In addition, operators must consist of an adequate number of suitable personnel to operate and maintain the equipment, processes and systems for the predisposal management of radioactive waste and for service systems. For all stages in the predisposal management of radioactive waste the operator must ensure that the operating, maintenance and technical staff understand the nature of the waste and its associated hazards as well as the relevant operating procedures and the associated safety procedures together with the procedures to be followed in the event of an incident or accident.[197] Disposal, storage and related aspects of radioactive waste are imperative and will be discussed in the following paragraphs.

4.5 Storage, transport and record keeping of radioactive waste

The storage of radioactive waste is an important stage of waste management that can be conducted over a long period of time. Before the placing of waste packages in storage facilities takes place the following measures must be implemented: waste packages must be properly identified; waste packages must not show signs of unacceptable deterioration and the necessary documentation and records must be available and acceptable.[198]

Furthermore all processes regarding waste treatment and packaging must be conducted satisfactorily and levels of surface contamination and surface dose rates must be on standard. One must also ensure that the measures for criticality control for “fissile” material are in place and that the intended movement of the radioactive waste within the storage facility can be conducted in a safe manner, preventing any accidents and minimising occupational exposures.[199] It must be ensured that the

196 IAEA *Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations*, Code and Safety Guides Q1–Q14 Safety Series No 50-C/SG-Q IAEA.

197 IAEA *Quality Assurance for Safety in Nuclear Power Plants and other Nuclear Installations*, Code and Safety Guides Q1–Q14 Safety Series No 50-C/SG-Q IAEA.

198 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 36.

199 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 36.

necessary procedures are in place to monitor the integrity of waste packages and included would be controlling the cooling and heating and performing the associated monitoring as well as maintaining the surveillance of the operational status of equipment for accident detection and mitigation of consequences. There must also be certainty that waste packages can be readily identified, located and accessed.[200]

The "inventory" of radionuclides along with the relevant properties and history of the waste forms must be recorded to ensure that the stability of the waste and the latter's radiological properties and in cases where gas is generated, the internal pressures of waste packages may be determined at any time during storage. The history of the radioactive waste (such as its origin, state of degradation when conditioned and treatment processes undergone) is essential when predicting its properties in the future as well as in tracing any recurrent or systematic fault.[201]

Attention must be paid to the possible necessity to relocate the waste in cases where problems may arise after such waste had been placed in storage. The latter would include instances where threats occur to the integrity of packages or where problems associated with criticality or decay heat may arise. It is also of importance to ensure that the availability of any specialised equipment that might be used over a long time period while waste packages are in storage or that could be required in future, must be assessed and secured.[202]

4.6 Transport

The operator must establish requirements and authorisations for ensuring the safety of on-site transport. Scenarios in which accidents give rise to the potential exposure of persons must be duly taken into account by the operator of the facility in the site emergency procedures. Radioactive waste must be adequately packaged and contained for transport by road, rail, air or sea in accordance with the national legal requirements. These national legal requirements must be based on the requirements

200 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 36.

201 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 36.

202 IAEA safety standards protecting people and the environment: *The Management System for the Processing, Handling and Storage of Radioactive Waste* Safety guide No GS-G-3.3 36.

established in international agreements.[203] The responsibility of the operators[204] is imperative and needs to be taken into account in the context of transport of radioactive waste.

4.7 Record keeping

The operator of a facility must establish a procedure for maintaining adequate documentation and records in accordance with a quality assurance programme.[205] The scope and detail of the records will depend on the hazard and/or the complexity of the proposed operation, and must be subject to approval by the regulatory body. These records must include the following:

> The data needed for a national inventory of waste; the data needed for waste characterisation; the records from the control processes for treatment, packaging and conditioning; the documents on the procurement of containers required to provide confinement for a certain period (e.g. in a repository); the specifications for waste packages and audit records for individual containers and packages; trends in operating performance; non-compliances with the specifications for waste packages and the actions taken to rectify them; the monitoring records; the results of safety assessments; the written operating procedures; and any additional data as required by the regulatory body.[206]

A waste characterisation record must contain the following information regarding the waste:

> The source or origin; the physical and chemical form; the amount (volume and/or mass); the radiological characteristics (the activity concentration, the total activity, the radionuclides present and their relative proportions); the classification in accordance with the national waste classification system; any chemical, pathogenic or other hazards associated with the waste and the concentrations of hazardous material; any special handling necessary owing to criticality concerns, the need for the removal of decay heat or significantly elevated radiation fields.[207]

It is clear that the IAEA sets comprehensive standards regarding the regulation of radioactive waste. It is important to comply with these standards of the IAEA in order

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203 IAEA Regulations for the Safe Transport of Radioactive Material 1996 Edition (Revised) Safety Standards Series No TS-R-1 (ST-1, Revised) IAEA Vienna (2000).

204 As discussed in 4.4.2.

205 IAEA Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations, Code and Safety Guides Q1–Q14 Safety Series No 50-C/SG-Q IAEA Vienna.

206 IAEA Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations, Code and Safety Guides Q1–Q14 Safety Series No 50-C/SG-Q IAEA Vienna.

207 IAEA Quality Assurance for Safety in Nuclear Power Plants and Other Nuclear Installations, Code and Safety Guides Q1–Q14,Safety Series No 50-C/SG-Q IAEA Vienna.

to conduct safe regulation of radioactive waste. It is therefore necessary to compare the South African legislation and standards to those of the IAEA in order to establish the quality of radioactive waste regulation in South Africa.

5 South African legal framework

Several acts in South Africa refer to the regulation of radioactive waste.[208] The policy underpinning radioactive waste will be discussed firstly, after which the legislation directly regulating radioactive waste will be discussed. Other legislation stipulations that exercise an impact on the regulation of radioactive waste from an environmental and health perspective will be discussed thereafter.

5.1 Policy

The Radioactive Waste Management Policy and Strategy for the Republic of South Africa[209] is an important document regarding the regulation of radioactive waste in in the country. This is due to the fact that the policy acknowledges the international principles[210] which were developed by the IAEA, regarding the regulation of radioactive waste and sets out the South African principles[211] according to which radioactive waste must be regulated.

The vision of the Radioactive Waste Management Policy and Strategy is *inter alia* to ensure the establishment of a comprehensive radioactive waste governance framework by means of formulating a policy and implementation strategy additional to nuclear and other applicable legislation.[212] The policy document not only provides for the principles radioactive waste needs to be regulated by, but also provides for the national legislation applicable to the regulation of radioactive waste in South Africa.

208 See 1.
209 Of 2005.
210 See International Radioactive Waste Management Policy Principles 8; see also par 3.
211 See National Radioactive Waste Management Policy Principles 8-9.
212 Department of Minerals and Energy: *Radioactive waste Management Policy and Strategy for the Republic of South-Africa*.

According to the *White Paper on Integrated Pollution and Waste Management for South Africa*[213] the objective for integrated pollution and waste management in South Africa is *inter alia* to prevent, reduce and manage pollution of any part of the environment due to all forms of human activity, and in particular from radioactive substances; to set targets in order to minimise waste generation and pollution at source and promote a hierarchy of waste management practices, namely reduction of waste at source, re-use and recycling with safe disposal as the last way out. Further objectives are to co-ordinate administration of integrated pollution and waste management through a single government department.[214] The notion of the *White Paper on Integrated Pollution and Waste Management* must be kept in mind when scrutinising the South African legislation applicable to the regulation of radioactive waste.[215] Before the South African legislation will be addressed it is necessary to first discuss the *Constitution of the Republic of South Africa*, 1996.

5.2 Constitution of the Republic of South Africa, 1996

The Constitution of the Republic of South Africa, 1996 is the cornerstone of environmental governance and therefore applicable to radioactive waste management. This is due to the provisions of the Bill of Rights that provides for various rights relevant to integrated pollution and waste management. These provisions are so important that legislation that does not comply with these rights is unconstitutional. The Constitution also establishes the legal basis for allocating powers to different spheres of government, and is therefore applicable to the regulation of integrated pollution and waste management. Section 24 contains the environmental clause of the Constitution and must be kept in mind at all times during radioactive waste management regulation. Keeping this in mind the South African legislation applicable to the regulation of radioactive waste will now be discussed.

5.3 Legislation directly applicable to regulating radioactive waste

213 Department of Environmental Affairs and Tourism A Policy on Pollution Prevention, Waste Minimisation, Impact Management and Remediation 17 March 2000 No 227.

214 Department of Environmental Affairs and Tourism *White Paper on Integrated Pollution and Waste Management for South Africa.*

215 See 6; see also Nuclear Energy Policy and Strategy for the Republic of South Africa July 2007.

As mentioned earlier there is national legislation that regulates radioactive waste in a direct and indirect sense. The directly applicable legislation will now be discussed followed by the indirect legislation.

5.3.1 National Nuclear Regulator Act

The main aim of the *National Nuclear Regulator Act*[216] is *inter alia* to establish a National Nuclear Regulator in order to regulate nuclear activities.[217] In order to regulate radioactive waste in terms of this act provision is made for the manner in which radioactive waste needs to be managed as well as provision for safety standards and regulatory practices for the protection of people, property and the environment against nuclear damage and matters connected therewith.[218] This act is furthermore applicable to the siting, design, construction, operation, decontamination, decommissioning and closure of any nuclear installation.[219] For purposes of the comparison between the IAEA standards and the South African standards it is important to note that this act aims to regulate the national obligations in terms of international legal instruments concerning nuclear safety.[220]

The IAEA sets standards for the handling of radioactive waste as well as the storage, transport, and disposal of radioactive waste and the safety standards connected therewith in order to protect human health and the environment as discussed in the previous paragraph.[221] The standards provided for in this Act now need to be compared to those standards set by the IAEA in order to measure the compliance of the *Nuclear Regulator Act* with the IAEA standards.

In order to develop a nuclear plant it is necessary to apply to the National Nuclear Regulator for authorisation.[222] This is necessary for the different phases in the nuclear cycle (from cradle to grave),[223] and therefore also in terms of radioactive

216 47 of 1999.
217 S3.
218 S5.
219 S 2(1)(a).
220 S5(b).
221 See also 4.
222 Ss 20 and 21.
223 See nuclear fuel cycle discussion above in 2.3.

waste.[224] It is, however, important to apply for these authorisations during the planning phase and not to leave the applications until a later stage.[225] According to the IAEA the application for authorisation is a necessity in terms of the responsibilities of the operators.[226] In terms of the South African context it is important that radioactive waste acceptance criteria in respect of waste disposal or storage facilities need to be established.[227] According to the GN R388 issued in terms of the *National Nuclear Regulator Act,* operations must be conducted in accordance with formal procedures as required by the conditions of the nuclear authorisation.[228] An appropriate maintenance and inspection programme must be established.[229] The maintenance and inspection programme must be implemented to ensure that the reliability and integrity of the installations, equipment and plant having an impact on radiation and nuclear safety are, commensurate with the dose limits and risk limits set by the Act.[230] This provision is similar to the IAEA standards[231] regarding storage, transport and record keeping.[232]

An adequate number of competent, qualified and trained staff must be responsible for carrying out the functions associated with radiation protection and nuclear safety and for maintaining an appropriate safety culture.[233] This provision complies with the standards set by the IAEA[234] as discussed earlier.

Regulation 4(6) of GN R388 sets the standards for radioactive waste and determines that a radioactive waste management programme must be established,[235] implemented and maintained in order to ensure waste generation control.[236] This

224 S 30 determines that only a holder of a nuclear installation licence is liable for all nuclear damage caused by or resulting from the relevant nuclear installation during the holder's period of responsibility.
225 Authorisation includes *inter alia* handling, transport, storage and disposal of radioactive waste.
226 See 4.4.2.
227 Reg 4(2)(3) published under GN R388 in GG 28755 of 28 April 2006 in terms of s 36, read with s 47 of the *National Nuclear Regulator Act* 47 of 1999, on Safety Standards and Regulatory Practices (hereafter GN R338).
228 Reg 4(2)(4).
229 Reg 4(3)(1).
230 Reg 4(3)(2); see Annexures 2 and 3.
231 See 4.5.
232 See table 1.
233 Reg 4(4)(1).
234 See 4.4.4; see also table 1.
235 Reg 4(6)(1).
236 Reg 4(6)(1)(1).

would include certainty about and proper documentation of "identification, quantification, characterisation and classification" of any radioactive waste generated.[237] According to the regulation provision is also made for the necessary treatment and other waste management steps leading to "safe clearance, or authorised discharge, disposal, reuse or recycling,"[238] as well as provides for the safe storage of radioactive waste between any waste management processes.[239] The safety of long-term radioactive waste storage options must be assured for the envisaged period of storage.[240] Radioactive material, radioactive contaminated material or radioactive waste may be removed from further compliance with the conditions of the nuclear authorisation if such material is transported to the site of any other authorised action or complies with the requirements for

> an authorised discharge; or authorised recycling or authorised reuse; clearance; or the material is transported directly to an authorised waste storage or disposal facility and complies with the applicable waste acceptance criteria.[241]

These provisions of the *Nuclear Regulator Act* also comply with the standards set by the IAEA regarding the handling, transport, storage and disposal of radioactive waste.[242] It is furthermore important to establish an environmental monitoring and surveillance which will be discussed in the following paragraph.

5.3.1.1 Environmental monitoring and surveillance

An appropriate environmental monitoring and surveillance programme must be established, implemented and maintained to verify that the storage, disposal or effluent discharge of radioactive waste comply with the conditions of the nuclear authorisation.[243]

5.3.1.2 Prior safety assessment

237 Reg 4(6)(1)(2).
238 Reg 4(6)(1)(3).
239 Reg 4(6)(1)(4).
240 Reg 4(6)(2).
241 Reg 4(6)(3)(1)-4(6)(3)(4).
242 See 4; see also table 1.
243 Reg 4(7); see IAEA standards 4.5-4.7.

Measures to control the risk of nuclear damage to individuals must be determined on the basis of a prior safety assessment which is suitable and sufficient to identify all significant radiation hazards and to evaluate the nature and expected magnitude of the associated risks.[244] Installations, equipment or plants requiring a nuclear installation licence or a certificate of registration and having an impact on radiation or nuclear safety must be designed, built and operated in accordance with good engineering practice.[245] A safety culture must be fostered and maintained to encourage a questioning and learning attitude to radiation protection and nuclear safety.[246]

5.3.1.3 Transport of radioactive material

Transport of radioactive material or of any equipment or objects contaminated with radioactive material off the site or on roads accessible to the public must be carried out in terms of the provisions of the IAEA Regulations for "The Safe Transport of Radioactive Material", in the revision specified in the nuclear authorisation.[247] Important legislation in South Africa in the context of transport includes the *National Road Traffic Act,*[248] the *National Nuclear Energy Act*;[249] the *National Nuclear Regulator Act*[250] as well as the *National Environmental Management: Waste Act*[251] and the *National Radioactive Waste Disposal Institute Act*.[252] The fact that has been stipulated that transport of radioactive waste[253] needs to be carried out in terms of the provisions of the IAEA Regulations for "The Safe Transport of Radioactive Material" makes it obvious that the South African standards in terms of this Act comply with the IAEA standards in the context of transport. As transport has to be conducted in terms of the IAEA regulations, no amendments need to be made to the South African legislation in this regard.

244 Reg 3(3).
245 Reg 3(4); see also IAEA standards discussed in 4.3-4.4.
246 Reg 3(5).
247 Reg 4(8); see also IAEA standards discussed in 4.6.
248 See 5.4.8.
249 See 5.3.2.
250 See 5.3.1.
251 See 5.4.2.
252 See 5.3.3.
253 See Reg 4(8).

5.3.1.4 Records and reports

A system of record-keeping for all records specified in the nuclear authorisation must be established, implemented and maintained.[254] Operational reports must be submitted to the National Nuclear Regulator at predetermined periods as specified in the nuclear authorisation and must contain such information as the National Nuclear Regulator may require on the basis of the safety assessments.[255] A reporting mechanism must be established, implemented and maintained for nuclear incidents and nuclear accidents or any other events that the Regulator may specify in the authorisation.[256] The annual report also needs to specify nuclear emergency planning and preparedness, the safety of sealed radioactive sources under the jurisdiction of the National Nuclear Regulator, nuclear incidents/accidents that were reported as well as the regulatory independent verification of radiological environmental analysis.[257] The magnitude of doses to individuals as well as the number of people exposed and the likelihood of incurring exposures must be kept (ALARA) during the project life cycle of a nuclear power plant,[258] with economic and social factors taken into account.[259]

Emergency or remedial measures must be considered in the vicinity of a possible nuclear accident where the potential exists that any member of the public may receive more than an annual effective dose[260] resulting from the accident.[261] Section 36 contains the safety standards and regulatory practices guidance in the context that the Minister must, on the recommendation of the board make regulations regarding safety standards and regulatory practices. According to section 37 in the case of a nuclear accident in connection with a nuclear installation, the holder of the nuclear authorisation must immediately report the accident to the National Nuclear Regulator and to any other person described in the nuclear authorisation. Section 39

254 Reg 4(10)(1); see also IAEA standards discussed in 4.5 and 4.7.
255 Reg 4(10)(2).
256 Reg 4(10)(3).
257 S 3.
258 This is especially important when handling and storing/ disposal of radioactive waste.
259 Reg 3(2).
260 1 mSv.
261 Reg 6(4); see also IAEA standards discussed in 4.3-4.4.

regards the record of nuclear installations and also stipulates that the regulator must keep

> a record of the particulars; a map showing the location; and where applicable, diagrams showing the position and limits of nuclear installations in respect of which a nuclear installation licence has been granted.

In terms of section 40 the regulator must keep and maintain a record of the details of every nuclear accident and nuclear incident. Such a record must be kept safely and must be kept for 40 years from the date of the nuclear accident or nuclear incident and must be made available on the request of any person. In the case of non-compliance section 52 sets out the offences and penalties.

GN 716[262] determines that the regulator must submit a public report to the executive authority on the health and safety related to workers as well as to the public and the environment associated with all sites on which a nuclear installation is situated or on which any action which has the potential to cause nuclear damage is carried out.[263] Section 3 of the regulation above stipulates that the annual report must contain information such as *inter alia* a list of all the authorised activities during the reporting period, a background description of the authorised activities and related radioactive material, the occupational exposure to radiation during normal operation as well as the projected public exposure to radiation during normal operation, nuclear safety of plant and operations, the competency and sufficiency of the operator workforce relating to work safety, safety measures of transport of radioactive waste and control of radioactive discharges into the environment.

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262 GN 716 in GG 29050 of 28 July 2006 Regulations in terms of s 7(1)(j) of the *National Nuclear Regulator Act* 47 of 1999, on the contents of the annual public report on the health and safety related to workers, the public and the environment related to all sites on which a nuclear installation is situated or on which any action which is capable of causing nuclear damage is carried out.

263 See also GN 581 in GG 26327 of 7 May 2004 that categorises nuclear installations in the Republic of South Africa based on the potential consequences of a nuclear accident as follows: Category 1: Koeberg Nuclear Power Station; Category 2: Safari-1 Research Reactor; Category 3: Vaalputs National Radioactive Waste Disposal Facility and certain installations at Pelindaba.

The South African standards of record keeping compare well with the standards set out by the IAEA as discussed above.[264] Other relative provisions regarding the regulation of radioactive waste will now be discussed.

5.3.1.5 Decommissioning strategy and planning

A decommissioning strategy must be submitted as part of the prior safety assessment and must be updated throughout the operation of the authorised action as a basis for detailed decommissioning planning.[265] A decommissioning plan must be submitted to the Regulator as a basis for authorisation of specific actions or phases of decommissioning,[266] and must specify any institutional controls that are required to maintain radiation safety after termination of the period of responsibility of the holder of the nuclear authorisation and must also minimise as far as reasonable the need for such institutional controls.[267] The issue regarding decommissioning is also addressed in the IAEA standards as discussed in the responsibilities of the operator. Further relative provisions regarding the regulation of radioactive waste will now be discussed.

5.3.1.6 Regulatory approval of radiation protection and nuclear safety measures

The holder of the nuclear authorisation is responsible for radiation protection and nuclear safety, including compliance with applicable requirements such as the preparation of the required safety assessments, programmes and procedures relating to the "siting, design, construction, operation and decommissioning" of facilities. Situations where formal approval of radiation protection and nuclear safety measures by the National Nuclear Regulator is necessary should be limited to those where this is appropriate taking into account the nature and extent of the risk and the need for building stakeholder confidence.[268]

264 See 4.5 and 4.7; See also 5.2.1.5 regarding decommissioning; see 5.2.3 for discussion regarding shortfalls in South African legislation; see also table 1 below.
265 See fn 193 Reg 5(1)(1) (hereafter Reg).
266 Reg 5(1)(2).
267 Reg 5(1)(3).
268 Reg 3(7).

If the prior safety assessment or operational safety assessment has identified the possibility of a nuclear accident, then accident prevention and mitigation measures based on the principle of defence in depth need to be implemented. These measures must address *inter alia* accident management procedures including emergency planning, emergency preparedness and emergency response. The principle of defence in depth must be applied as necessary,[269] and will be discussed shortly in the following paragraphs.

5.3.1.7 Defence in depth

A defence in depth system,[270] of provisions for radiation protection and nuclear safety commensurate with the likelihood of the potential exposures involved must be applied to sources so that a failure at one layer is compensated for or corrected by subsequent layers, for the purposes of

> preventing nuclear accidents; mitigating the consequences of any such accidents; and restoring sources to safe conditions after any such accident.[271]

A quality management programme must be established, implemented and maintained in order to ensure compliance with the conditions of the nuclear authorisation.[272]

5.3.1.8 Requirements applicable to regulated actions

The following requirements apply to actions authorised by a nuclear installation licence or certificate of registration: an operational safety assessment must be done and submitted to the National Nuclear Regulator at intervals specified in the nuclear authorisation and which must be commensurate with the nature of the operation and the radiation risks involved;[273] operational safety assessments must be of "sufficient scope" and must be done and maintained in order to demonstrate continuing

269 Reg 3(8).
270 Or multi-layered system.
271 Reg 3(9).
272 Reg 3(10); see IAEA standards discussed in 4.3-4.4.
273 Reg 4(1)(1).

compliance with the dose, risk limits and other relevant conditions of the nuclear authorisation.[274]

The operational safety assessment must also establish the basis for all the operational safety-related programmes, limitations and design requirements.[275] The holder of a nuclear authorisation is restricted to the actions within the specified site and within any limitations imposed in the authorisation.[276] Technical specifications must be established, implemented and maintained, in terms of the safety assessment.[277] Such operating technical specifications must provide a link between the safety assessment and the operation and must, as a minimum include the following:

> operating safety limitations as imposed by the design or by the safety criteria; surveillance requirements to verify that equipment important to safety is operating satisfactorily or that parameters are within the safety limitations; and limitations on the operation, in the event that equipment important to safety becomes inoperable or in the event that safety limitations are exceeded.[278]

The standards of the IAEA in terms of handling, storage, transport and disposal are incorporated in the Nuclear Regulator Act.[279] It is not only the Nuclear Regulator Act that regulates radioactive waste, but there are various other acts applicable in the context of the regulation of radioactive waste. These acts will also be compared to the IAEA standards in the following paragraphs starting with the *Nuclear Energy Act.*[280]

5.3.2 Nuclear Energy Act

The main aim of this Act[281] is to provide for the establishment of the South African Nuclear Energy Corporation[282] and to prescribe measures for the discarding of

274 Reg 4(1)(2).
275 Reg 4(1)(3).
276 Reg 4(2)(1).
277 Reg 4(2)(2).
278 Reg 4(2)(2)(1)-4(2)(2)(3).
279 See table 1; see also discussion of IAEA and SA standards compared in 6.
280 46 of 1999.
281 46 of 1999.
282 S 3.

radioactive waste and the storage of irradiated nuclear fuel.[283] The act defines radioactive waste as "any radioactive material destined to be disposed of as waste material."

Authorisations from the Minister of Energy are necessary for conducting nuclear activities as well as certain activities relating to nuclear material, restricted material and nuclear-related equipment and material.[284] Discarding of radioactive waste and storage of irradiated nuclear fuel require the written permission of the Minister of Energy and are subject to any conditions that the Minister, in concurrence with the Minister of Water and Environmental Affairs, deem fit to impose. The conditions so imposed will be additional to any conditions contained in a nuclear authorisation as defined in the *National Nuclear Regulator Act*.[285]

The Act determines that any person who possesses, uses, handles- or processes nuclear material[286] and therefore radioactive waste, needs to keep the prescribed records as well as submit the prescribed reports to the Minister at the prescribed intervals or events as well as conduct prescribed measurements on nuclear material and maintain the prescribed measuring control programmes.[287]

This Act further determines that IAEA inspectors may conduct their inspections as necessary.[288] This implies that the *Nuclear Energy Act* acknowledges some of the IAEA standards and that the regulation of radioactive waste needs to be done according to the standards of the IAEA. Except for the authorisation, record keeping and reporting the writer could not procure any concurrence between the *Nuclear Energy Act* and the IAEA standards. This implies that there are defects in this Act in terms of IAEA standards. Although this Act does not explicitly address the regulation of radioactive waste in the context of setting standards, as mentioned above, the fact that the Act allows for IAEA inspectors to conduct inspection implies that this Act accepts the standards set by the IAEA.

283 S 44-50.
284 S 34(1).
285 S46.
286 Nuclear material means source material and special nuclear material.
287 S 33.
288 S 33(J).

5.3.3 National Radioactive Waste Disposal Institute Act

A juristic person known as the National Radioactive Waste Disposal Institute is established in section 3 of the Act[289] in order to perform any function that may be assigned to it by the Minister of Energy in terms of section 55(2)[290] of the *Nuclear Energy Act*, in relation to radioactive waste disposal; design and implement disposal solutions for all classes of radioactive waste;[291] develop radioactive waste acceptance and disposal criteria in compliance with applicable regulatory health, safety and environmental requirements and any other technical and operational requirements.[292]

The institute must also assess and inspect the acceptability of radioactive waste for disposal and issue radioactive waste disposal "certificates; manage, operate and monitor operational radioactive waste disposal facilities," including related storage and predisposal management of radioactive waste at disposal sites. The institute must manage and monitor closed radioactive waste disposal facilities and investigate the need for any new radioactive waste disposal facilities and sites as well as design and construct such new facilities that may be necessary.[293]

Research and development plans must be done for the long-term management of radioactive waste storage and disposal. A national radioactive waste database must be maintained and a report published on the inventory and location of all radioactive waste in the Republic. The institute must manage the disposal of any ownerless radioactive waste on behalf of the state, including the development of radioactive waste management plans for such waste and must assist generators of small quantities of radioactive waste in all technical aspects related to the disposal of such

289 53 of 2008.
290 The Minister may assign any institutional obligation to the Corporation or any statutory or other body, which has the capacity to fulfil the Republic's responsibilities with regard thereto.
291 The Act defines radioactive waste as any radioactive material destined to be disposed of as waste material, and 'nuclear waste' has a similar meaning; radioactive material is defined as any substance consisting of, or containing, any radioactive nuclide, whether natural or artificial, including, but not limited to, radioactive waste.
292 S 5.
293 S 55(2).

waste as well as implement any assignments or directives from the Minister regarding radioactive waste disposal.[294]

According to section 55 the Institute must further provide information on all aspects of radioactive waste disposal to the public in general living in the vicinity of radioactive waste disposal facilities; co-operate with any person or institution on matters relating to the performance of any duty and perform any other function necessary to achieve the objects of this Act. It is furthermore important to note that if a person has to dispose of radioactive waste he/she needs to apply to the Chief Executive Officer[295] for a radioactive waste disposal certificate.[296] The generators of radioactive waste are responsible for the "technical, financial and administrative management" of the waste within the national regulatory framework at their premises and when the waste is transported to an authorised waste disposal facility.[297] The generators of radioactive waste remain responsible for all liabilities in connection with their radioactive waste under their control until the time that the radioactive waste has been received and accepted in writing by the institute, following an inspection at which time liability shall pass to the Institute.[298]

There are currently not many facilities in South Africa where radioactive waste can be stored. The reason for this is the fact that there are many requirements that a facility needs to comply with in order to ensure the safe disposal of radioactive waste over the short, medium and long term.[299] The main disposal facility is Vaalputs[300] approximately 100km South-East of Springbok in the Northern Cape which mainly accommodates low to medium level radioactive waste.[301] HLW is currently being stored in underground facilities at Pelindaba and Koeberg. This is due to various problems, for example, the danger of transporting HLW for long distances and the

294 S 55(2).
295 Of the National Radioactive Waste Disposal Institute.
296 S 23.
297 S 25.
298 S 25.
299 For example, low rainfall, low agriculture, mining or economic growth potential; stable seismic conditions; low population density; suitable surface and groundwater conditions; distant from international borders etc.
300 Vaalputs and Holfontein only accommodate low and intermediate radioactive waste.
301 Vaalputs *the National Radioactive Waste Disposal Facility* Managed by Necsa on behalf of the South African Government.

appropriateness of the existing disposal facilities.[302] The fact of the matter is that these facilities are reaching their capacities and are in the close vicinity of humans.[303] Solutions to these problems must be developed and rather urgently so. The writer is of the opinion that the above legislation complies with some of the IAEA standards.[304]

5.4 Legislation indirectly applicable on regulating radioactive waste

As mentioned above[305] there is legislation in South Africa that regulates radioactive waste in an indirect manner. Such legislation will now be unpacked in terms of the relevant provisions.

5.4.1 Hazardous Substances Act[306]

The *Hazardous Substances Act* does not address the radioactive waste that comes from nuclear power plants, but regulates other types of radioactive waste.[307] The *Hazardous Substances Act* provides for the control of Groups III and IV hazardous substances. These substances include radioactive material not found at nuclear installations or not part of the nuclear fuel cycle, for example, fabricated radioactive sources, medical isotopes and Group III hazardous substances involving exposure to ionising radiation emitted from equipment.[308]

In terms of this Act the Department of Health's Directorate of Radiation Control is the national competent authority in connection with the International Atomic Energy Agency's Regulations for the Safe Transport of Radioactive Material.[309] This implies that the *Hazardous Substances Act* acknowledges the standards of the IAEA to be the standards that need to be followed when transporting radioactive waste. The object of this Act is *inter alia* to regulate substances which may have a negative

302 Swanepoel *High-level nuclear waste*.
303 Swanepoel *High-level nuclear waste*.
304 See table 1 for comparison of IAEA and SA standards.
305 See 1.
306 15 of 1973.
307 For example medical radioactive waste.
308 Department of Minerals and Energy *Radioactive Waste Management Policy and Strategy for the Republic of South Africa* 11.
309 Department of Minerals and Energy *Radioactive Waste Management Policy and Strategy for the Republic of South Africa* 11.

impact due to their nature or properties as well as to divide those substances into categories and to regulate the "importation, manufacture, sale, use, operation, application, modification, disposal or dumping" of those substances and products.[310]

As in the case of the previous acts it is also necessary to apply for authorisation when any activity regarding any hazardous substance is conducted.[311] Except for authorisation in terms of disposal of this waste, the Act further provides for the disposal of imported waste which is not the focus of this study.

Due to the fact that the *Hazardous Substances Act* does not regulate radioactive waste generated by the nuclear fuel cycle and the fact that the *National Environmental Management: Waste Act*[312] now regulates hazardous waste the *Hazardous Substances Act* will not be discussed further and a discussion of the *Waste Act* will be conducted in the following paragraph.

5.4.2 National Environmental Management: Waste Act

The object of the *National Environmental Management: Waste Act*[313] is *inter alia* to reform the law regarding waste management in order to protect human health and the environment by means of preventing pollution and ecological degradation and by ensuring ecologically sustainable development. Further objects of the Act are to establish national norms and standards for regulating the management of waste by all spheres of government as well as to provide for specific waste management measures; to establish the licensing and control of waste management activities and to provide for the national waste information system along with compliance and enforcement.[314]

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310 15 of 1973.
311 S 3A.
312 59 of 2008.
313 59 of 2008 (hereafter *Waste Act*).
314 Waste means "any substance, whether or not that substance can be reduced, re-used, recycled and recovered- (a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of; (b) which the generator has no further use of for the purposes of production; (c) that must be treated or disposed of; or (d) that is identified as a waste by the Minister by notice in the *Gazette*, and includes waste generated by the mining, medical or other sector, but- (i) a by-product is not considered waste; and (ii) any portion of waste, once re-used, recycled and recovered, ceases to be waste."

Authorisation to store or dispose of waste in terms of this Act is also required.[315] An interesting provision in the Act states that the Waste Act does not apply to radioactive waste that is regulated by the *Hazardous Substances Act*, the *National Nuclear Regulator Act* or the *Nuclear Energy Act* as already discussed earlier.[316] This in essence means that the Waste Act does not apply to the regulation of radioactive waste. The Act will, however, still be applicable to any other radioactive waste not mentioned in section 4 of the Act.

5.4.3 Mineral and Petroleum Resources Development Act

The object of the *Mineral and Petroleum Resources Development Act*[317] is to provide for "equitable access to and sustainable development" of South Africa's mineral and petroleum resources as well as to provide for related matters.[318] The holder of a prospecting or mining right is obliged to manage all environmental impacts according to an approved environmental management programme or plan and would as far as reasonably possible need to rehabilitate the affected environment.[319] If one scrutinises the nuclear project lifecycle,[320] there are various steps involved in the lifecycle e.g. uranium prospecting, mining, production and disposal.[321] The Act does not explicitly refer to radioactive waste and therefore if mining waste occurs to be radioactive it needs to be regulated in terms of the *Nuclear Energy Act*, the *Nuclear Regulator Act* and the *National Radioactive Waste Disposal Institute Act.*[322]

It is important to note that the principles set out in section 2 of NEMA apply to all prospecting and mining operations, and any matter relating thereto.[323] The MPRDA does not directly address radioactive waste, but is still important to keep in mind

315 S 45.
316 S 4(1)(a); see 5.3.1-5.3.2 and 5.4.1.
317 28 of 2002 (hereafter MPRDA).
318 28 of 2002.
319 Department of Minerals and Energy *Radioactive Waste Management Policy and Strategy for the Republic of South Africa* 11.
320 See 2.3.
321 See also Chapter 4 of the Act; authorisation is necessary for these activities.
322 See 5.3.1 to 5.3.3.
323 S 37.

during the nuclear project life cycle due to the fact that radioactive waste is a product resulting from, for example, uranium mining.[324]

5.4.4 Mine Health and Safety Act[325]

The *Mine Health and Safety Act* regulates the protection of the health and safety of employees and other persons at mines. Any hazardous materials "fall under the inspection and enforcement tasks of the Mine Health and Safety Inspectorate."[326] The Act does not make explicit reference to radioactive waste, but can be seen as a good guidance regarding the overall health and safety of people working at a mine.[327]

5.4.5 National Water Act

The aim of the *National Water Act*[328] is to reform the law relating to water resources as well as to repeal certain laws and to provide for matters connected therewith.[329] The *National Water Act* is also indirectly applicable to radioactive waste due to the fact that the Act itself does not refer to radioactive waste, but rather provide for terms such as waste[330] or substances and pollution.[331]

The Act determines that an owner of land,[332] on whose land activities will take place that may cause pollution must take all reasonable measures to prevent any

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324 IAEA Nuclear Fuel Cycle Information System 11.
325 29 of 1996.
326 Department of Minerals and Energy *Radioactive Waste Management Policy and Strategy for the Republic of South Africa* 11.
327 29 of 1996; see also *Occupational Health and Safety Act* 85 of 1993.
328 36 of 1998 (hereafter *Water Act*).
329 36 of 1998.
330 Defined as "any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause, the water resource to be polluted."
331 Defined as "the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it-(a) less fit for any beneficial purpose for which it may reasonably be expected to be used; (b) harmful or potentially harmful-(aa) to the welfare, health or safety of human beings; (bb) to any aquatic or non-aquatic organisms; (cc) to the resource quality; or (dd) to property; radioactive waste therefore comply with the characteristics of these terms in order to make the *National Water Act* applicable on the regulation of radioactive waste."
332 Or a person in control of land or a person who occupies or uses the land.

pollution.[333] If it seems that pollution will occur, authorisation from the Minister of Water and Environmental Affairs is required.[334] It must be noted that pollution due to radioactivity must be prevented at all times.[335]

5.4.6 Dumping at Sea Control Act

The *Dumping at Sea Control Act*[336] regulates the control of dumping of substances in the sea. Authorisation from the Minister of Water and Environmental Affairs is required to dump waste into the sea. Schedule 1 determines that high-level radioactive waste or other high-level radioactive matter prescribed by regulation is a prohibited substance, and according to schedule 2, radioactive waste or other radioactive matter not included in schedule 1 is a restricted substance.[337] This Act prohibits the dumping of "high-level" radioactive waste as set out in schedule 1 or other high-level radioactive matter at sea.[338]

5.4.7 National Environmental Management Act

The object of the *National Environmental Management Act*[339] is *inter alia* to provide for co-operative environmental governance by means of principles regarding decision-making on matters that affect the environment as well as to provide for institutions that will promote cooperative governance and procedures for co-ordinating environmental functions exercised by organs of state.[340]

NEMA is a framework act for environmental management and must be taken into account in all instances regarding the environment.[341] The Act provides for principles that are applicable throughout the country and it needs to be implemented during

333 S 19(1).
334 S 21.
335 See GN 704 in GG 20119 of 4 June 1999 regarding Regulations on use of water for mining and related activities aimed at the protection of water resources.
336 73 of 1980.
337 See schedule 1 and 2.
338 S 2.
339 107 of 1998.
340 107 of 1998.
341 S 2(b).

decision-making on matters affecting the environment.[342] Due to the fact that radioactive waste has a detrimental effect on the environment and on humans,[343] these principles set out in NEMA are also applicable to the regulation of radioactive waste.[344]

The provisions of NEMA must be taken into account during the nuclear life cycle along with certain regulations.[345] GN R545[346] for instance, determines that an EIA must be done where the intention is to construct facilities or infrastructure for nuclear reaction including energy generation, the production, enrichment, processing, reprocessing, storage or disposal of nuclear fuels as well as radioactive products and nuclear and radioactive waste. An EIA therefore needs to be done according to NEMA in order to determine the effect that radioactive waste would have on the environment.

Section 2(4) of NEMA determines that decisions regarding the environment must be taken in an open and transparent manner. There must be intergovernmental co-ordination and harmonisation of policies, principles and actions. Actual and potential conflicts of interest between organs of state must be resolved through conflict resolution mechanisms.[347] The latter applies to all organs of state whose actions may significantly affect the environment. These principles serve as a general framework within which environmental management and implementation plans should be formulated and also serve as guidelines that must be used when decisions are made about issues that may have an impact on the environment.[348] The principles should also guide the interpretation, administration and implementation of NEMA or any other law that is concerned with the protection or management of the environment.[349]

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342 S 2.
343 See 2.7 above.
344 See also 3.
345 S 24.
346 GN R545 in GG 33306 of 18 June 2010 regarding EIA's.
347 Du Plessis *Legal Mechanisms* 7; Section 2(2) also states that environmental management should place people and their needs at the forefront of its concern and their physical, psychological, developmental, cultural and social interests should be addressed equitably. Development should be socially, environmentally and economically sustainable (s 2(3)).
348 Strydom and King "Environmental Management" 202.
349 S 2(1); see also Strydom and King "Environmental Management" 202; Du Plessis *Legal Mechanisms* 8.

The Act furthermore determines that every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring.[350] If such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, the person that causes the pollution would have to minimise and rectify such pollution or degradation of the environment.[351]

5.4.8 National Road Traffic Act[352]

The transportation of radioactive waste is regulated by various acts,[353] but the most important Act is the *National Road Traffic Act* 93 of 1996 and its regulations.[354] These regulations deal with the transportation of dangerous goods[355] and therefore with radioactive waste. The duty of care principle is an important aspect of this process and places a burden on the waste generator to ensure that the waste is packaged, transported, treated and disposed of in terms of legal requirements and that there is an auditable cradle-to-grave "paper trail to cover" all the steps involved.[356]

The *National Road Traffic Act* incorporates various SANS Codes of Practice into the provisions of the Act regarding the transportation of hazardous waste. The regulations[357] provide for a number of activities that will be mentioned shortly. These activities include *inter alia* the identification and classification of dangerous goods; the packaging of dangerous goods for road and rail transportation; intermediate bulk containers for dangerous goods; the regulations provide for the inspection requirements for road vehicles as well as the operational requirements thereof along with emergency information systems and Emergency Response Guides.[358]

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350 S 28(1).
351 S 28(1); see also s 30 regarding the Control of emergency incidents.
352 93 of 1996.
353 See 5.3.1 to 5.3.2.
354 See chapter 8.
355 Dangerous goods means the commodities, substances and goods listed in the standard specification of the South African Bureau of Standards SABS 0228.
356 Chapter 8.
357 Administered by the Department of Transport and the associated SANS Codes.
358 See SANS Codes 10228; 10229; 10233; 10230; 10231; 10232-1; 10232-2; 11398; 11518.

The South African legislation that addresses radioactive waste is fragmented and causes the departments that are involved in the regulation of radioactive waste to be fragmented.[359] It is therefore not possible to only apply legislation that regulates radioactive waste in a direct manner, but it is also necessary to take into account legislation that regulates the environment and human health.

Some of the short falls in the South African legislation include factors such as limits of impact management; limited civil society involvement; inadequate integration of environmental media; inadequate integration across government departments; lack of capacity to implement legislation and inadequate consideration of global environmental issues.[360]

6 Conclusion

The aim of the study was to determine whether the South African legislation complies with the international standards in order to address the fragmentation in the regulation of radioactive waste in South Africa.[361] Radioactive material means any substance consisting of, or containing, any radioactive nuclide, whether natural or artificial. Radioactive waste can therefore be defined as any radioactive material destined to be disposed of as waste material.[362]

Radioactive waste may have detrimental effects on human health and the environment and is classified according to the concentration of radioactive activities in the specific waste.[363] A distinction is drawn between low, intermediary and high levels of radio activity in order to address the activity content, radiotoxicity and

359 On fragmentation see Du Plessis *Legal Meganisms* 5; Nel, Kotzé and Snyman *Strategies to integrate environmental policy* 3-4; *Constitution of the Republic of South-Africa*, 1996; Strydom and King "Environmental Management" 18; Kotzé *Environmental Governance* 110; Kidd *Environmental Law* 207-208.
359 Scholtz *Cooperative Governance* 269-276.
359 Bosman, Kotzé and Du Plessis *SA Public Law.*
360 These shortfalls will not be further discussed due to the fact that this dissertation focuses mainly on the standards regarding the handling, transport, storage and disposal of radioactive waste; see table in 6 for a comparison between South African legislation and IAEA standards.
361 See 1.
362 See 2.
363 See 2.1.

thermal power.[364] Due to the international importance of the treatment of radioactive waste, the IAEA establishes international standards for the management, processing, handling and storage of radioactive waste. The standards relate to safety for the protection of human health, the environment and the minimisation of danger to life and property, and to deal with the implementation of these standards. South Africa as a member of the IAEA takes the standards set by the IAEA into account in its nuclear and related legislation.[365]

There are various acts regulating radioactive waste in South Africa either directly or indirectly and various decision-makers govern radioactive waste, environmental and health protection. A comparison of international waste management standards with South African standards is illustrated in Table 1 below.

Table 1: Comparison between IAEA and South African standards

IAEA Regulatory Control of Radioactive Discharges to the Environment, Safety Standards Series	South African legal framework	
SHORT DESCRIPTION	ACT	SHORT DESCRIPTION
Handling radioactive waste to protect human health and the environment to the predisposal management of radioactive waste.	National Nuclear Regulator Act	In order to regulate radioactive waste in terms of this act provision is made for the manner in which radioactive waste needs to be managed as well as to provide for safety standards and regulatory practices for the protection of people, property and the environment against nuclear damage and matters connected therewith This act is furthermore applicable to the siting, design, construction, operation, decontamination, decommissioning and closure of any nuclear installation
Safety requirements for the predisposal management of high	Nuclear Energy Act: section 55 (2)	In relation to radioactive waste disposal; design and implement disposal solutions for all classes of radioactive waste.

364 See 2.1.
365 See 5.3.

level radioactive waste, which includes high level waste (HLW) in liquid form and solidified form.	Hazardous Substances Act: section 3A	No person shall produce or otherwise acquire, or dispose of, or import into the Republic or export from there, any Group IV hazardous substance, except in terms of a written authority under subsection (2) and in accordance with- (a) the prescribed conditions; and (b) such further conditions (if any) as the Director-General may in each case determine.
Roles and responsibilities of the regulator and operators: The national legal system may permit the issuing of site specific regulations for the predisposal management of radioactive waste.	Reg 4(2)(3) of GN R388 in GG 28755 of 28 April 2006	Radioactive waste acceptance criteria in respect of waste disposal or storage facilities must be established.
Responsibilities of the regulatory body: To review and assess submissions on safety from the operators; to issue, amend, suspend or revoke authorisations; to carry out regulatory inspections; to ensure that corrective actions are taken if unsafe or potentially unsafe conditions are detected and to take the necessary enforcement action in the event of a violation of the regulatory	Reg 4(7) of GN R388 in GG 28755 of 28 April 2006 National Environmental Management: Waste Act: Subsection 1	An appropriate environmental monitoring and surveillance programme must be established, implemented and maintained to verify that the storage, disposal or effluent discharge of radioactive waste complies with the conditions of the nuclear authorisation. The Minister must establish a national waste management strategy for achieving the objects of this Act, which must include: objectives, plans, guidelines, systems and procedures relating to the protection of the environment.

Responsibilities of the operators: Before construction or significant modification of a facility for the predisposal management of radioactive waste can be done, the operator must submit to the regulatory body an application detailing the proposed design and operational practices together with a safety assessment.	Reg 3(4) of GN R388 in GG 28755 of 28 April 2006	Installations, equipment or plants requiring a nuclear installation licence or a certificate of registration and having an impact on radiation or nuclear safety must be designed, built and operated in accordance with good engineering practice.
Control of waste generation: Keeping the volume of waste to the minimum.	National Radioactive Waste Disposal Institute Act: S 55(2)	The Institute must also assess and inspect the acceptability of radioactive waste for disposal and issue radioactive waste disposal "certificates"
Qualifications of staff: Must undertake a specified training programme that will ensure that they understand the processes involved and the interrelationships of all stages in the process of waste management as well as the consequences of operator error for safety and the generation of waste.	Mine Health and Safety Act 29 of 1996: s 10 S 11	Every employer must provide employees with the necessary "information, instruction, training or supervision" that is needed to enable them to perform their work safely and without risk to their health. States that employers must identify the hazards to health or safety to which employees may be exposed while they are at work, assess the risks.
Storage of radioactive waste: Waste packages must be properly identified; waste packages must not	National Radioactive Waste Disposal Institute Act: s 25	The Minister must establish a national waste information system for the recording, collection, management and analysis of data and information that must include: data on the quantity and type or classification of waste generated, stored, transported, treated, transformed,

show signs of unacceptable deterioration and the necessary documentation and records must be available and acceptable.	NEMWA: s 60	reduced, re-used, recycled, recovered and disposed of; and a register. The institute must assess and inspect the acceptability of radioactive waste for disposal and issue radioactive waste disposal "certificates; manage, operate and monitor operational radioactive waste disposal facilities," including related storage and predisposal management of radioactive waste at disposal sites. The institute must manage and monitor closed radioactive waste disposal facilities and investigate the need for any new radioactive waste disposal facilities and sites as well as design and construct such new facilities that may be necessary
	Dumping at Sea Control Act: s 3	Authorisation from the minister is required to dump waste into the sea.
	Mine Health and Safety Act 29 of 1996: s 21(4)	This section determines that every person who "manufactures, imports or supplies any hazardous substance" for use at a mine must ensure that the substance is safe and without risk to health and safety when "used, handled, processed, stored or transported"
Transport of radioactive waste: Operator must establish requirements and authorisations for ensuring the safety of on-site transport. Radioactive waste must be adequately packaged and contained for transport by road, rail, air or sea in accordance with the national legal requirements.	Reg 4(8) of GN R388 in GG 28755 of 28 April 2006 NEMWA: s 60	Transport of radioactive material or- any equipment or objects contaminated with radioactive material off the site or on roads which are accessible to the public, must be carried out in terms of the provisions of the IAEA Regulations. The Minister must establish a national waste information system for the recording, collection, management and analysis of data and information that must include: data on the quantity and type or classification of waste generated, stored and transported. The duty of care principle is an important aspect of this process and places a burden on the waste generator to ensure that the waste is packaged, transported, treated and disposed of in terms of legal

		requirements and that there is an auditable cradle-to-grave "paper trail to cover" all the steps involved.
	National Road Traffic Act	The National Road Traffic Act incorporates various SANS Codes of Practice into the provisions of the Act regarding the transportation of hazardous waste. The regulations provide for a number of activities that will be mentioned shortly. These activities include inter alia the identification and classification of dangerous goods; the packaging of dangerous goods for road and rail transportation; intermediate bulk containers for dangerous goods; the regulations provide for the inspection requirements for road vehicles as well as the operational requirements thereof along with emergency information systems and Emergency Response Guides
Record keeping of radioactive waste: The operator of a facility must establish a procedure for maintaining adequate documentation and records in accordance with the quality assurance programme.	National Nuclear Regulator Act: s 39 Reg 4(10)(1) of GN R388 in GG 28755 of 28 April 2006	This section regards the record of nuclear installations. GN 716 determines that the regulator must submit a public report to the executive authority on the health and safety related to workers; the public and the environment associated with all sites. A system of record keeping for all records specified in the nuclear authorisation must be established, implemented and maintained.
IAEA principles:		**SA principles:**
Protection of Human Health		Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably (NEMA section 2(2))
Protection of the Environment		S 24 Constitution; S 2(4) NEMA
Protection of Future Generations		Principle of Sustainable Development – s 2(4) NEMA
Precautionary principle		S 28(1) NEMA; S 19(1) Water Act; S 37 Mineral and Petroleum Resources

		Development Act
Polluter pays principle		S 28 NEMA; S 19 *Water Act*; S 37 MPRDA.
Control of Radioactive Waste Generation		Transparency regarding all aspects of radioactive waste management (NEMA s 2(4)(k)) Sound decision-making based on scientific information, risk analysis and optimisation of resources (NEMA s 2(4))
Safety of Facilities: The safety of facilities for radioactive waste management shall be appropriately assured during their lifetime		The right of workers to refuse work that is harmful to human health or the environment and to be informed of dangers must be respected and protected. (NEMA s 2(4)(j)) Responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle(NEMA s 2(4)(e)) **Other:** Co-operative governance and efficient national co-ordination (Ch 3 Constitution; s 2(4)(l) NEMA); s 6 (National Nuclear Regulator Act); cooperative agreements concluded in terms of the National Nuclear Regulator Act. Public Participation (e g S 2(4)(f) NEMA; S 24(g) NEMA; S 6 (National Nuclear Regulator Act); Capacity building and education (S 2(4)(f) (NEMA)

From Table 1 it seems that the South African legislation consists of relative comprehensive standards in the context of radioactive waste regulation, and that the IAEA standards are incorporated into the South African law. The IAEA regulations of radioactive waste provisions are, however, scattered over a number of South African statutes. There is no single South African statute that complies with the standards of the IAEA on its own and this makes the sound regulation of radioactive waste very difficult.

There are various international principles as well as national principles according to which radioactive waste needs to be regulated. The IAEA principles are mostly incorporated into the South African principles.[366] This can, for example, be seen in section 2 of NEMA. These principles are, however, not included in the nuclear or radioactive waste legislation.

Due to the fragmentation of legislation, the governance of radioactive waste is also fragmented. Radioactive waste is regulated by the National Nuclear Regulator, the National Radioactive Waste Disposal Institute; the Department of Health, the Minister of Energy, the Minister of Water and Environmental Affairs, the Department of Water Affairs, the Department of Environmental Affairs and the Department of Mineral Resources to mention but a few. This state of affairs may create un-coordinated regulation of radioactive waste resulting in environmental and health challenges.

The following recommendations may accordingly be made:

1. The ideal would be that all radioactive waste should be regulated by one act. In such a case it might be a good idea to use the National Radioactive Waste Disposal Institute Act as it creates an independent body to deal with the licencing of discarding or certain radioactive waste. This will relieve the different departments from making decisions on radioactive waste management that may be in conflict with one another. If the Institute is to deal only with high level radioactive waste, then the NEMWA should deal with all other radioactive waste – also radioactive waste generated by mines to ensure that a coordinated approach regarding health, safety and environmental protection is followed.

2. Radioactive waste should be clearly defined in the Act or by lack of a specific Act the sector-specific acts should be clear on which type of waste it is dealing with. At this stage there is still great uncertainty amongst government departments with regard to the handling of some types of waste.

366 See also par 3.

3. However, by lack of a specific mandate and in a case where government departments may not want to abandon their mandates with regard to radioactive waste, the cooperative agreements that the National Nuclear Regulator concluded with some government departments and branches of government departments should be extended to all government departments dealing with radioactive waste. The draft cooperative agreements should be finalised. The cooperative agreements should not only be concluded between the NNR and specific government departments, but the other government departments should also conclude cooperative agreements or Memoranda of Understanding with each other with regard to the handling of radioactive waste to ensure that a coordinated approach is followed.

4. The principles underlying radioactive waste management should be included in the legislation dealing with radioactive waste – either directly or with reference to section 2 of NEMA. Section 2 of NEMA should be made applicable not only to the government departments but also to the generators of radioactive waste. The principles not included in NEMA must be specifically mentioned in the *National Nuclear Energy Act*; *National Nuclear Regulator Act* and the *National Radioactive Waste Disposal Institute Act*.

5. Although the South African legislation provides in general terms for the IAEA standards, it does not necessarily include the specifics. The regulations dealing with the handling, transport, storage and disposal of radioactive waste should clearly indicate what steps should be followed. Where the nuclear legislation and regulations do not provide for certain measures but other legislation deals with a specific measure, for example with regard to water or transport, the nuclear regulations or legislation must be amended to provide for these measures. Another way to ensure that the IAEA standards are properly incorporated into South African legislation is by referring to the specific standards in the legislation and so to incorporate them into the day to day practice of radioactive waste management.

6. An inter-ministerial committee and an inter-departmental technical committee could be established in terms of the Intergovernmental Relations Framework

Act 13 of 2005 that deals specifically with matters relating to the management of radioactive waste.

It is necessary for South African legislation to comply with IAEA standards. Compliance with the IAEA standards could ensure that radioactive waste management would be holistically addressed. If the IAEA standards could be incorporated into legislation to ensure that all radioactive waste could be dealt with by one independent Institute or by one government department, the issue of fragmentation could be addressed effectively. However, in the event of that proving to be unattainable it would nevertheless be necessary to ensure that the environment, health and safety of people are protected by cooperative agreements to ensure that all the "loops" are closed and that all matters prescribed by the IAEA standards are addressed by South African legislation and administrative practices.

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